The Philippine Journal of Agriculture

[Formerly THE PHILIPPINE AGRICULTURAL REVIEW]

VOL. IV THIRD QUARTER, 1933 NO. 3

A PROGRESS REPORT ON THE CULTURE OF TURKISH TOBACCO

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ONE PLATE

Turkish tobacco is famous all over the world for its delicate and peculiar aroma. It is also high-priced, and for this reason it is generally used only for blending purposes in the manufacture of the higher-priced brands of cigarettes. It is characteristically small-leafed. Clarke(1) reports that the usable leaf of the Turkish tobacco grown in California ranges from 2 to 10 inches (5 to 25.4 centimeters) in length and from 1 to 6 inches (2.5 to 15.2 centimeters) in width. He states further that this range in size is found on the same plant from the largest leaves at the bottom to the smallest leaves at the top. In fact the leaves are very much smaller than those of Virginia or Philippine tobacco, and the yield is correspondingly small, but this disadvantage is more than offset by the high price it commands in the market. According to the local distributor of a popular brand of cigarettes, first-class Turkish leaf tobacco sells for as much as 40 pesos [1] per kilo.

The present investigation has been conducted to find out the soil and climatic requirements of the Turkish variety Samsoun Bafra, to study its cultural requirements, and to determine how

[1] One peso Philippine currency equals 50 cents United States currency.

Philippine-grown Turkish tobacco will compare with tobacco from other countries.

The investigations were conducted principally at Alabang, in Rizal Province, and Muñoz, in Nueva Ecija Province, from October, 1932, to April, 1933. Trial plantings were also made at Sucat, in Rizal, and at Gagalangin, a barrio of Manila.

PLAN OF THE WORK AT ALABANG, RIZAL

Sowing of seed and care of seedlings.—The seed was sown October 8, 1932, in well-pulverized soil, at the rate of 1 gram for every square meter of seed bed. The seed beds were provided with a portable cover. When the seedlings had about two pairs of leaves they were thinned and pricked, so as to be about 5 centimeters apart.

Land preparation.—The soil is a heavy clay-loam. It is hard when dry and very sticky when wet. The land was plowed and harrowed twice with a tractor before it was planted. Furrows 80 centimeters apart were made with a native plow. As the soil was quite hard, holes 70 centimeters apart were dug to a sufficient depth along the furrows with a native hoe.

Transplanting.—The seedlings were transplanted to the field December 8, 1932. They should have been transplanted several days earlier, but the torrential rains at the time rendered the soil too sticky to be worked. The seedlings were set in the holes by pressing the soil down gently around the base of the plant.

Cultivation.—When the seedlings were well established in the soil the first cultivation was done by breaking the soil particles around the base of the plants with garden hoes. A week later the plow was passed twice between the rows. The process was repeated at regular intervals of two weeks until the plants were too big for the operation.

Control of insect pests and diseases.—In combating the tobacco worms occasional applications of calcium arsenate powder mixed with fine road dust, 1: 16 by volume, were made. This treatment was supplemented by picking the worms by hand. The stem-borer, which was abundant in the field, was prevented from further spreading by destroying all the attacked plants. In like manner all the plants that showed symptoms of mosaic and root-rot diseases were removed from the field as fast as they were noticed.

Topping.—In order to determine the effect of topping on the yield and color of the leaves some experiments were performed.

Topping was done in four ways; namely, (*a*) cutting off the bud before the flower head appeared, (*b*) removing the flower head as soon as it appeared, (*c*) cutting off the flower head as soon as the flowers opened, and (*d*) trimming off the flower head as soon as the capsules were formed.

Five rows of one hundred plants each were used for each treatment. The yields from each row were taken separately, then calculated on a hectare basis. The average yield per hectare, the probable error of the mean, and the probable error of the difference were computed (Table 1).

TABLE 1.—*Effect of topping on the yield and color of leaves of the Turkish cigarette tobacco variety Samsoun Bafra*

TREATMENT 1. UNTOPPED OR CONTROL

Row No.	Computed yield per hectare	D	D^2
	Quintals		
A–1	10.00	—2.35	5.5225
A–2	13.57	+1.22	1.5084
A–3	15.00	+2.65	7.0225
A–4	11.78	—0.57	0.3249
A–5	11.42	—0.93	0.8649
Average	12.35		$\sum d^2$ 15.2432

$M = 12.35 \pm 0.5888$

TREATMENT 2. THE BUD WAS PINCHED OFF BEFORE THE FLOWER HEAD APPEARED

B–1	13.93	+1.42	2.0164
B–2	12.14	—0.37	0.1369
B–3	11.80	—0.71	0.5041
B–4	13.61	+1.10	1.2100
B–5	11.07	—1.44	2.0736
Average	12.51		$\sum d^2$ 5.9410

$M = 12.51 \pm 0.3675$

$B — 12.51 \pm 0.3675$
$A — 12.35 \pm 0.5888$
0.16 ± 0.6940

TREATMENT 3. THE FLOWER BUD WAS CUT OFF AS SOON AS IT APPEARED

C–1	12.49	—0.54	0.2916
C–2	14.79	+1.76	3.0976
C–3	12.85	—0.18	0.0324
C–4	13.21	+0.18	0.0324
C–5	11.82	—1.21	1.4641
Average	13.03		$\sum d^2$ 4.9181

$M = 13.03 \pm 0.3344$

$C — 13.03 \pm 0.3344$
$A — 12.35 \pm 0.5888$
0.68 ± 0.6771

TABLE 1.—*Effect of topping on the yield and color of leaves of the Turkish cigarette tobacco variety Samsoun Bafra*—Continued

TREATMENT 4. THE FLOWER HEAD CUT OFF AS SOON AS THE FLOWER OPENED

Row No.	Computed yield per hectare	D	D^2
	Quintals		
D–1	12.51	—1.01	1.0201
D–2	14.28	+0.76	0.5776
D–3	13.57	+0.05	0.0025
D–4	12.19	—1.33	1.7684
D–5	15.06	+1.54	2.3716
Average	13.52	.....	$\sum d^2$ 5.7407

$M = 13.52 \pm 0.3613$

$D - 13.52 \pm 0.3613$
$A - 12.35 \pm 0.5885$

1.17 0.6908

TREATMENT 5. THE FLOWER HEAD CUT OFF AS SOON AS THE CAPSULES WERE FORMED

E–1	10.71	—2.53	6.4009
E–2	13.93	+0.69	0.4761
E–3	13.21	—0.03	0.0009
E–4	15.35	+2.11	4.4521
E–5	13.00	—0.24	0.0576
Average	13.24	.....	$\sum d^2$ 11.3876

$M = 13.24 \pm 0.5089$

$E - 13.24 \pm 0.5089$
$A - 12.35 \pm 0.5885$

0.89 ± 0.7782

SUMMARY OF TABLE 1

Treatment No.	Mean	Difference against control	Remarks
1 [a]	12.35 ± 0.5888	.....	No appreciable difference in the color of leaves as noted.
2	12.51 ± 0.3675	0.16 ± 0.6940	
3	13.03 ± 0.3344	0.68 ± 0.6771	
4	13.52 ± 0.3613	1.17 ± 0.6908	
5	13.24 ± 0.5089	0.89 ± 0.7782	

[a] Control.

Harvesting.—Several methods of harvesting the leaves were tried to determine which method would be the most practical to use. (*a*) Leaves in different stages of maturity were harvested when dark green, when light green, and when ranging from light yellow to bright yellow. (*b*) The leaves were allowed to dry in the field. (*c*) The entire crop of leaves was harvested at one time by cutting off the stalk of the plant at the base before the flowers appeared, when the flowers appeared, and when the capsules were formed. Notes on the color of the leaves were taken after curing.

Curing.—Some curing tests were also performed. The curing methods tried were (*a*) under a nipa shed, (*b*) under a gal-

vanized-iron roof, (*c*) partly under a nipa shed and partly in the sun, and (*d*) completely in the sun. Each method was tested three times. The colors of the leaves cured under the different methods were compared.

Studies on some characters of the variety.—In order to have definite information about this variety the following characters were studied: Height of plant, number of leaves per plant, length and width of standard leaves, percentage of dry weight of leaves on the basis of green weight, form and shape of leaves, texture of leaves, and period of flowering. The first four characters named were also studied in Maligaya, Nueva Ecija. One hundred plants were used as the basis of study. In each case the mean, the standard deviation, and the coefficient of variation were computed (Table 2).

TABLE 2.—*Comparison of Samsoun Bafra variety grown at Alabang and at Maligaya*

COMPARISON OF HEIGHT OF PLANTS OF THE SAMSOUN BAFRA VARIETY GROWN AT ALABANG AND AT MALIGAYA

Locality	Range of variation	Total population	Mean	Standard deviation	Coefficient of variation
	cm.				
Alabang	75–145	100	108.9±1.15	17.08±0.81	15.68±0.39
Maligaya	85–145	100	103.3±0.88	13.09±0.62	12.67±0.30

COMPARISON OF NUMBER OF STANDARD LEAVES OF THE SAMSOUN BAFRA VARIETY GROWN AT ALABANG AND AT MALIGAYA

	cm.				
Alabang	16–36	100	26.6±0.32	4.87±0.23	18.31±0.46
Maligaya	16–36	100	24.8±0.41	6.13±0.29	24.73±0.62

COMPARISON OF LENGTH OF STANDARD LEAVES OF THE SAMSOUN BAFRA VARIETY GROWN AT ALABANG AND AT MALIGAYA

	cm.				
Alabang	16–37	100	26.08±0.35	5.26±0.25	20.19±0.89
Maligaya	16–40	100	25.24±0.26	4.00±0.19	15.85±0.39

COMPARISON OF WIDTH OF STANDARD LEAVES OF THE SAMSOUN BAFRA VARIETY GROWN AT ALABANG AND AT MALIGAYA

	cm.				
Alabang	8–22	100	14.84±0.21	3.15±0.15	21.22±0.55
Maligaya	10–20	100	14.02±0.13	2.21±0.09	16.24±0.40

In the study of the relative weights of cured and green leaves ten determinations were made. The mean and the probable error of the mean were computed (Table 3).

TABLE 3.—*Green and dry weights and percentages of dry weight of leaves*

Determination	Green weight	Dry weight	Per cent dry weight	D	D^2
	g.	g.			
1	228	40	17.54	—0.47	0.2209
2	217	39	17.97	—0.04	0.0016
3	197	34	17.25	—0.76	0.5776
4	202	34	17.32	—0.69	0.4761
5	216	38	17.59	—0.42	0.1764
6	170	32	18.82	+0.81	0.6521
7	209	39	18.66	+0.65	0.4225
8	175	30	17.14	—0.87	0.7569
9	193	36	18.65	+0.64	0.4096
10	219	42	19.17	+1.16	1.3456
Average			18.01		$\sum d^2$ 5.0393

$$M = 18.01 \pm 0.0377$$

TRIAL CULTURE AT GAGALANGIN, MANILA

The seedlings planted in this place came from Alabang. They were planted at practically the same time as in Alabang. The field has been used as a dumping place for all kinds of refuse of late years, so that the soil is friable and comparatively rich in organic matter. The mechanical composition is more or less sandy loam. The lot is owned by the Samson brothers, owners of La Conchita Cigar Factory.

TRIAL CULTURE AT SUCAT, RIZAL

The field is located along the shore of Lake Bay (Laguna de Bay). Because the field was under water until the month of December, 1932, it was not planted until the middle of January, 1933. The seedlings used for planting were raised in that place. The seed was sown during the first week of December, 1932.

The soil is light and porous. It is a silty to sandy loam in physical character, and moist even during the driest part of the year, because the water table is only a few inches below the surface of the ground. This land belongs to Mr. Posadas, collector of Internal Revenue.

DISCUSSION AND RESULTS

Observations on seedlings.—It was observed that the seedlings of Turkish tobacco were more delicate than the seedlings of the other varieties of tobacco. About 50 per cent of the seedlings in Alabang died when they were transplanted in the field. Because of the delicate nature of the stems and leaves, the seedlings succumbed easily to the heat of the sun. For this reason, unless the transplanting is done during cloudy days, it is necessary that the seedlings be covered for the first three or four days to

protect them from the sun. The seedlings are also susceptible to the stem-borer. This is especially true of the older seedlings in the seed beds. The presence of these insects could easily be detected because of the characteristic swelling of the stem of the infested plants. It has been observed that once the plants are attacked by this pest they remain stunted. So it is best to discard all the infested seedlings as soon as they are noticed.

The relation of organic matter and moisture in the soil to the quality of the leaves.—The present investigations revealed some interesting facts about the relation of moisture and organic matter in the soil to the vegetative growth of the plants and quality of the leaves. For instance, in Alabang, where the soil used was heavy clay but well drained, the leaves in the field were generally light in color, and when the same leaves were cured they turned out golden yellow, aromatic, and sweetish in taste.

In Sucat, where the soil was much lighter but moist throughout the year, the plants produced plenty of suckers, and the leaves were coarse and dark green in the field. When the same leaves were cured they either turned greenish or dark brown and were very brittle.

On the other hand, in Gagalangin, where the soil was also friable and relatively rich in organic matter, the plants developed were taller, with larger leaves, than those grown in either Alabang or Sucat. The leaves were thinner, however. The cured leaves were light brown or greenish but were of good burning quality.

The conditions mentioned in the foregoing two paragraphs refer to the earlier harvests. During the latter part of the season, however, because of drought resulting in the lowering of the water table in both places, the leaves improved in both color and aroma.

Effect of topping on the yield and color of leaves.—Table 1 shows that the topped plants have larger yields than the controls. The differences, however, are insignificant. For instance, in the case of treatment 2, the mean difference is even less than the probable error of the difference. In treatments 3 and 5 the mean differences are almost as great as the probable error of the difference. In treatment 4, in which the mean difference is supposed to be the greatest, it is also insignificant, since it is only about one and one-half times the probable error of the difference.

With regard to the effect of topping on the color of the leaves, as far as the variety under consideration is concerned, no differences in color of the leaves were observed between the check and the treated leaves and even among leaves under the different treatments.

Effect of harvesting and curing on the color of leaves.—In the harvesting experiments the only method that gave really satisfactory results was method 2, whereby the leaves were harvested when they had turned light green. The leaves became bright yellow after curing.

The different methods of curing studied had practically the same effect on the color of the leaves. They differed only in the length of time necessary to cure the leaves. The various methods with the corresponding average number of days it took to cure the leaves were as follows: complete sun curing, 12 days; under a nipa shed then in the sun, 13.3 days; under a galvanized iron roof, 14.6 days; under a nipa shed, 15.6 days.

Height of plants.—Referring to Table 2 it will be seen that the height of plants in Alabang was from 75 to 145 centimeters, while in Maligaya it was from 85 to 145 centimeters. The mean, standard deviation, and coefficient of variation were generally higher in Alabang.

Number of leaves.—In Table 2 it will be seen that the number of leaves of the plants in both places ranged from 16 to 36. The mean was higher for Alabang but the standard deviation and coefficient of variation were lower.

Length of leaves.—The length of leaves in Alabang ranged from 14 to 34 centimeters. In Maligaya, 16 to 40 centimeters. The mean, standard deviation, and coefficient of variation were a little higher in Alabang (Table 2).

Width of leaves.—The width of the standard leaves in Alabang varied from 8 to 22 centimeters. In Maligaya, 10 to 20 centimeters. The mean standard deviation and coefficient of variation were also higher in Alabang (Table 2).

Percentage of dry weight of leaves.—Referring to Table 3 it will be seen that the percentage of dry weight of the leaves ranged from 17.14 to 19.17 per cent. The average of the ten determinations is 18.01 ± 0.0377.

Form and shape of leaves.—In form and shape the leaves are very similar to our native Romero, being heart-shaped and characteristically petiolate.

Texture of leaves.—The laminas are smooth and silky. The midribs and veins are very fine.

Period of flowering.—The variety begins to flower in 100 to 115 days from the time of sowing the seed.

SUMMARY AND CONCLUSIONS

1. The Turkish tobacco type is in a class by itself, both from the standpoint of development of the plants in the field and the quality of the cured leaf products.

2. The average size of the middle standard leaves compares favorably with the maximum size of leaves produced in California.

3. Turkish tobacco thrives in a wide range of soils, provided that these are well drained. Excess moisture in the soil is detrimental to the quality of the leaves. And soil that is rich in organic matter has a tendency to increase the size of the leaves, causing them to lose their peculiar aroma, while apparently poorer soils insure the peculiar desirable qualities of this type of tobacco.

4. From the standpoint of golden yellow color and sweetish aroma the sun-cured leaves produced at Alabang were the best.

5. The variety under study seems to be variable with respect to such characters as height of plants, number of leaves per plant, and length and width of the middle standard leaves. The measurements were higher than those reported by Paguirigan.(2)

6. High topping did not produce any significant effect on the yield and color of the leaves.

7. The average yield per hectare of this variety in Alabang, Rizal, is about 12 quintals. It is higher than the yields obtained at the Ilagan Tobacco Station during the 1928–1929, and 1931–1932 seasons.(3)

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ILLUSTRATION

PLATE I

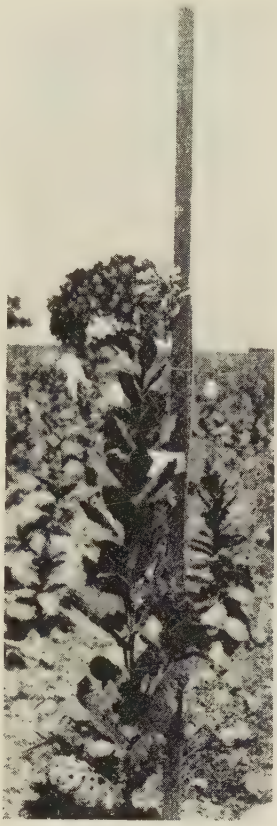
FIG. 1. Typical plant of the Samsoun Bafra (Turkish) tobacco variety grown in silty loam soil. Note the broadness of the leaves.

2. Typical plant of the Samsoun Bafra (Turkish) tobacco variety grown in clay loam soil.

3. Plot of Samsoun Bafra (Turkish) tobacco variety grown in a loam soil rich in organic matter, Gagalañgin, Manila.

4. Typical top and middle standard leaves of the Samsoun Bafra (Turkish) tobacco variety.

1



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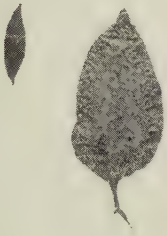

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PLATE I

A SURVEY OF THE VEGETABLE INDUSTRY IN BAGUIO AND IN TRINIDAD VALLEY, MOUNTAIN PROVINCE, LUZON

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TWO PLATES

The vegetable gardens in Baguio and in Trinidad Valley, Mountain Province, are considered the most extensive as well as the most intensive truck-farming project in the Philippines. Practically all of Guisad and Lucban Valleys and all the sections of Trinidad Valley suitable for vegetable growing are devoted to the industry. A conservative estimate places the area set out in vegetables in 1932 at over 200 hectares, and they grow virtually all the year round.

This investigation was undertaken to find out what practices make the industry successful, and to gather information that would be useful in the promotion of vegetable growing in the lowlands. It was also thought that it might show some possible ways to maintain or improve the industry.

This work was undertaken by the writer during his stay at the Baguio Semi-temperate Fruit Station, Baguio, Mountain Province, from October, 1930, to August, 1932.

HISTORY OF THE INDUSTRY

People who have lived in Trinidad Valley and Baguio for the last sixty-five years claim that some sort of vegetable growing was done there by the natives and the few Spanish missioners before American occupation. The Spaniards introduced the Irish potato, and although the natives were naturally lazy about cultivating it, through some forced means at first, they came to like it and finally grew it quite extensively.

Camotes and gabe were the two staple crops, and together with other vegetables, they were grown in the higher portions of Trinidad Valley. The valley about fifty years ago was almost all under water during the greater portion of the year,

due to the lack of adequate drainage canals. Towards the end of the Spanish régime cabbages, radishes, and lettuce were grown in kitchen gardens of Spanish residences. Cabbages were propagated almost wholly by slips or branches.

The rapid development of the vegetable industry began during the early part of American occupation. As early as 1903 an experiment station (Trinidad Garden) was established in Trinidad Valley, at the present site of the Trinidad Agricultural School, by the Government, under the old Bureau of Agriculture. The station had for its primary purposes the "testing of temperate and tropical vegetables, . . . and the experimental marketing of the ordinary varieties which can be economically produced in wholesale quantities." While the station did not last long, as it was ceded to the Bureau of Education, its work served as an eye-opener to the great possibilities of Baguio and Trinidad Valley in the growing of high-priced and insistently demanded temperate and semi-temperate vegetables. As one superintendent of the station reported, ". . . this work (vegetable growing) has reached the stage where it is an unquestionable success, and as a consequence many of the Igorots and Ilocanos are starting vegetable gardens of their own."

The establishment of the Trinidad Agricultural School further assisted the development of the industry. The children of the natives were afforded the rare opportunity of learning the art and science of vegetable growing in the school. At the present time, many of the most successful gardeners among the natives are alumni of the school. The construction of a canal by the school to drain the valley also greatly increased the area that could be devoted to vegetable growing.

Japanese as well as Chinese gardeners, particularly the former, have contributed a great deal towards the development of the vegetable industry. As early as 1898, a Japanese settled in Trinidad Valley and did some home gardening. In 1907 there were as many as twenty-five Japanese gardeners in the whole valley, and in 1930 there were fifty of them actually engaged in vegetable gardening besides a goodly number that were working as laborers under Japanese gardeners.

The Japanese gardeners introduced Japanese methods and practices. It was a Japanese who first used a glasshouse for the raising of seedlings for planting purposes. This was in 1907.

It was also either a Japanese or Chinese gardener who introduced the use of the "raised bed" method, which is now universally followed in the valley, including the Trinidad Agricultural School.

In the raised bed, the land is so worked that the soil in the plot is very much higher than the paths. In the valley the beds are about 1 meter wide, accommodating two rows and of any convenient length. The paths are like drainage canals between the plots.

This method, while more expensive than the "flat method," because it involves a great deal of manual labor, the use of animal-drawn implements not being feasible, has several advantage over the latter. Among the most important are that it insures thorough preparation of the soil, leaving a deep medium of friable yet firm and mellow soil; it insures thorough drainage even during the rainy season; and it provides paths without sacrificing space. Thus the soil intended for plants is never stepped on and compacted.

The Japanese gardeners are also credited with the introduction of some of the vegetable crops that are widely grown in the valley. The most important is the Japanese-Irish potato.

The Chinese contributed no less towards the development of the vegetable industry in Trinidad Valley. In 1907, perhaps, encouraged by the success of the old Bureau of Agriculture in raising semi-temperate vegetables, a number of Chinese gardeners went there to try their luck. By 1916, there were about forty of them, and their number has been about the same to the present time. Like the Japanese, because of their diligence and great preseverance in working against great odds, and because of their experience in their own country, they have contributed much to bringing the industry to its present status. The introduction of the Shanghai cabbage, one of the kinds best adapted to local conditions, and undoubtedly the best variety for rainy season planting, is attributed to the Chinese gardeners. And so with the Chinese green onion; two varieties of the common bean, *Phaseolus vulgaris;* and the Chinese cabbage, *Brassica pekinensis,* a very delicious type of pechay.

The thoroughness with which the soil is prepared for planting and the more or less free use of manures, especially crop residues, may be rightly attributed to either the Chinese or the Japanese.

THE SOIL AND CLIMATE OF BAGUIO AND TRINIDAD VALLEY

Soil.—The common soil in Baguio and in Trinidad Valley is red clay. This soil is very sticky when wet, but it crumbles easily upon exposure to air and sun as it lacks soil colloids. However, it is not the kind that is found in the valley which are devoted to the growing of vegetables. That soil is generally made up of decomposed shales and the sedimentary lime rock that is abundant in many of the mountains surrounding the valleys. In many places it is liberally intermixed with silt containing some sand. Originally it must have been poor, but it has been brought to its present state of fertility through the lavish use of plant residues, ashes, stable manures, and commercial fertilizers.

Climate.—The portions of Baguio and Trinidad that are suitable for the growing of vegetables have an elevation of about 1,400 meters above sea level. The climate is agreeable, especially during the dry months, when it is cool and decidedly refreshing.

Baguio and the surrounding country enjoy the first type of climate, having a wet and a dry season that are quite distinct. The rainy season extends from May to October, during which time there is an excessively heavy rainfall, especially during the months of July and August. A study of Table 1 will give some idea as to the climate of Baguio and its immediate vicinity.

TABLE 1.—*Showing the average monthly rainfall, number of rainy days per month, temperature, and relative humidity in Baguio for a period of ten years, 1922–1931* [a]

Climatic factor	Month						
	Jan.	Feb.	Mar.	Apr.	May	June	July
Amount of rainfall.....mm...	10.3	15.4	32.4	105.9	388.8	550.9	935.4
Rainy days.....	3.7	2.4	5.1	9.4	23.2	24.8	28.3
Temperature .....°C..	16.9	17.2	18.1	18.9	18.9	18.5	18.0
Relative humidity.....	77.8	77.3	79.0	81.5	87.9	90.7	92.1

Climatic factor	Month					Total
	Aug.	Sept.	Oct.	Nov.	Dec.	
Amount of rainfall.....mm...	1,157.1	608.9	326.3	107.0	30.1	4,268.5
Rainy days.....	27.7	25.8	19.2	10.2	5.9	185.7
Temperature.....°C..	17.6	18.0	18.0	17.9	17.2	.....
Relative humidity.....	93.7	92.0	88.4	83.8	79.1	.....

[a] Data compiled from the Weather Bureau records.

As seen in Table 1, while the relative humidity is high, the temperature is comparatively low, approaching that of temperate countries, thus making the region suitable for the growing of semi-temperate and some temperate crops.

PRESENT STATUS OF THE INDUSTRY

Area under cultivation.—In 1903, only an insignificant portion of the entire Guisad, Lucban, and Trinidad Valleys were planted to gabe and sweet potatoes, but by 1930 the whole of the Guisad and Lucban Valleys and about half of Trinidad Valley had been turned into intensive truck gardens. A conservative estimate for that year placed the area devoted to vegetables at over 200 hectares.

Classes of gardeners.—For the purpose of this paper, the gardeners may be classified as owners and tenants. Owner-gardeners are natives who have acquired the art of gardening through schooling or through their association with Chinese or Japanese gardeners. The tenant-gardeners seem to be more numerous and most of them are Chinese and Japanese. They are more progressive than the first group of gardeners. The tenant-gardeners hire the land on which they work for a number of years, paying from 150 to 300 pesos a hectare a year. A few shrewd Japanese and Chinese have married native women, thus becoming entitled to work the land of their wives.

The owner-gardener cultivates about one-fourth to one-half a hectare. In general he does not employ any labor; he works his garden with the aid of his family. On the other hand, the tenant-gardener handles from one to three hectares. He employs laborers ranging in number from three per hectare during the rainy season to eight per hectare during the busiest season of the year.

Principal crops grown and their relative importance.—When one goes to the Baguio market, he will be impressed with the array of different kinds of vegetables. It will be noted, however, that only a few crops are grown on a large scale. The principal reasons are the demand for these particular crops, and the income that can be realized from their culture.

The most popular and widely grown crop in the whole region is undoubtedly the cabbage. It is safe to state that about three-fourths of the whole area devoted to vegetables is planted to

cabbages. Next in importance are pechay (mostly the type that produces a head), beans, strawberries, green onions, peas, sweet potatoes, and Irish potatoes. Lettuce, celery, carrots, beets, tomatoes, cauliflowers, peppers, eggplants, cucumbers, kohlrabi, spinach, chayotes, rhubarb, leeks, endive, etc., are grown in limited areas to supply the local demands and sometimes for shipment to Manila.

TABLE 2.—*The more-important vegetables and the more commonly grown varieties under each*

Cabbage:
- Shanghai. Best for rainy season culture.
- Flat Dutch. } Best for dry season culture.
- Succession. }
- Allhead Early.

Pechay:
- Wong Bok. Produces head.
- Chinese.

Beans:
- Chinese Black.
- Chinese Wax.
- Kentucky Wonder (black).
- Canadian Wonder.

Peas:
- Alderman.
- Chinese.

Irish potato:
- Japanese White.
- Japenese Red.
- Spanish. Neutralized.

Green onions:
- Chinese.
- Japanese.

Sweet potato:
- Native. Several varieties.
- American. Unidentified.
- Samar Big Yellow.

Peppers:
- Rubi King.
- Chinese Giant.

Tomato:
- Ponderosa.
- Marglobe.

Beets:
- Improved Blood.

METHODS OF CULTURE IN VOGUE

The method of culture in Trinidad Valley and in Baguio is distinctly Oriental. This is as is to be expected, because the leading gardeners are Japenese and Chinese. Even the Trinidad Agricultural School, the principal of which is an American, employs the "raised bed" system (Plate I, fig. 1). "We have to adopt the system (raised bed) if we want to get the maximum yield," the principal once said.

Preparation of the soil.—The preparation of the soil for planting vegetables in the whole district is done by manual labor except in the Trinidad Agricultural School and the Baguio Semitemperate Station, where animal labor is employed to a certain extent. Raised beds are made no matter what crops are raised. The soil, however, is easy to prepare, except for the newly reclaimed areas bordering the lake. It crumbles easily even if it is rather wet due principally to the combined effects (*a*) of continuous cropping, which prevents the excessive growth of weeds and at the same time renders the soil soft, and (*b*) of the continuous heavy applications of stable manures, ashes, and crop residues in the form of humus. The Igorots from different parts of the Mountain Province supply most of the labor. The daily wage ranges from 60 to 80 centaves, with free food, but the working hours are from daybreak until quite dark in the evening.

For the preparation of the soil, the Japanese hoe (the blade is similar to the tines of a spading fork, but mounted like that of a grub hoe) is the one that is used almost exclusively. This hoe is used for digging the soil, pulverizing it, and making holes in which to set out the plants so that in itself are combined the plow, the harrow, and the trowel of the vegetable gardener in Baguio and in Trinidad Valley. Spading forks, garden hoes, and rakes are seldom if ever used except in the Baguio Semitemperate Station and in the local agricultural school.

In the preparation of the soil, there is one unique practice employed that farmers in the lowlands should think about. All crop-remains, like leaves, stems or vines, stubs, etc., including all weeds, are collected and never mixed or buried in the soil. If they were then they would be bound to have some bad effect on the following crop inasmuch as no time would be given them

to decay, even only partially, before planting. Such materials are not burned, however, as in the lowlands, but are gathered and dumped into a compost pit (Plate I, fig. 2) where they decay for future use.

Sources of seed.—Except as to native vegetables, and to some extent beans, peas, and perhaps lettuce, pechay, radishes, and other minor vegetables, the vegetable industry in Baguio and the Trinidad Valley is dependent upon foreign or imported seeds. Cabbage, potato, beet, celery, endive, carrot, etc., seeds are imported from the United States, Japan, China, and perhaps from other countries. Many of the vegetables grown in the Trinidad Valley do not produce seeds, or if they do produce them, such seeds may not be as good as those from foreign countries. This feature of the industry is not satisfactory, at its best. The presence of serious pests and diseases in the valley are attributed to the importation of seeds.

Raising of seedlings.—The use of good seedlings for planting purposes is one of the principal factors in the successful growing of vegetables. Because of the excessive rainfall from May to October, and because of the rather low temperature from November to February, the use of a glasshouse (Plate II, fig. 2) was found indispensable. The soil in the glasshouse is raised about 30 centimeters above the surrounding ground. The bottom layer is composed of gravel and sand to provide good drainage, while the top soil is composed of sandy loam, mixed with plenty of organic matter and a little ash. The top soil is changed at least once a year. Gardeners who cannot afford to put up a glasshouse build a shed for the raising of seedlings or grow their seedlings in boxes. Seedlings produced by the last two methods are very much inferior to those raised in glasshouses.

Vegetable crops like cabbage, pechay, onion, pepper, eggplant, tomato, lettuce, celery, kohlrabi, cauliflower, etc., are first grown in seed beds and then are transplanted in the garden when they are big enough. Many of the gardeners broadcast their seeds on the surface of a well-prepared bed, be it in a glasshouse or in the open, and cover them with fine soil and a little ash. The more progressive ones sow their seeds thick in a certain section of the glasshouse and then prick the seedlings later on. While this method is certainly more expensive, the uniform stand of the seedlings, to say nothing of their stoutness, and the effect of these in the subsequent stand of the crop in the field warrant the practice of the pricking method.

MANURES AND COMMERCIAL FERTILIZERS

One who is not informed concerning the extent to which stable manures and commercial fertilizers are used in connection with vegetable-growing in the valley will wonder how it is possible to raise three or more crops a year on the same piece of land year after year, knowing, as already stated in the first part of of this article, that the rainfall is indeed excessive and raised beds are employed—all conducive to the facile washing off and leaching out of plant food materials. Although the gardeners probably are not thinking of their duty to posterity to maintain the fertility of the soil for generations yet unborn, the fact is that they apply great quantities of farm manures and commercial fertilizers to the soil. They do realize that they cannot be producing good crops all the time from the same piece of ground without returning what they get from the soil in the form of fertilizers.

In the valley, commercial fertilizers, stable manures, ashes, and all sorts of crop residues are applied to the soil frequently and in great quantities. The liberal use of farm manures, commercial fertilizers, insecticides, and fungicides has caused a comparatively high production cost,[1] but is one of the principal factors responsible for the success of the industry.

Stable manure, ash and compost.—The soil in the vegetable gardens in the valley is friable and black, and at the same time firm and mellow. This condition is principally due, not to the nature of the soil, for it is generally red and sticky, but to the heavy application of organic matter in various forms. No crop is grown without the application of some compost and commercial fertilizers. The soil, therefore, may be manured and fertilized three or more times a year, depending upon the number of crops grown.

The common sources of organic matter are stable manures, compost from crop residues and weeds, and the charcoal[2] of pine leaves and grass. Soybean cake and fish meal, which are used in great quantities, are also good sources of organic matter.

[1] It costs from 7 to 8 centavos to raise one cabbage plant from seed to maturity.

[2] This charcoal (locally known as ash) is made by burning pine leaves and partially dried grass. After it is charred, it is sprinkled with water so as to prevent the total conversion of the stuff into ash. Analysis made by the Bureau of Science gives the following composition: P_2O_5, 0.68 per cent; K_2O, 0.79 per cent. One can of this ash weighs about 6.36 kilos and sells for from 8 to 12 centavos.

These are partially rotted first by thoroughly moistening them for a couple of days before applying them. The garbage collected in the City of Baguio is burned in an incinerator, and the ash is sold to the gardeners.

Commercial fertilizers.—Commercial fertilizers like stable manures and composts are applied in great quantities. The gardeners realize that without the use of some commercial fertilizers, vegetable crops of fine quality cannot be produced.

The commonest commercial fertilizers used in the valley are ammonium sulphate, fish meal, soybean cake, superphosphate, guano, and sulphate of potash.

Method of mixing and applying fertilizers.—The way fertilizers are mixed is based upon practical experience. The gardeners invariably get a good stand of crops because of the fact that they mix different kinds of fertilizers, that naturally supply the three important manurial elements. The writer saw a number of gardeners who mixed about six parts of stable manure or compost, three parts of soybean cake and fish meal, and one part of potash and phosphorus fertilizers. This combination is claimed to be good for any crop. Ash is generally applied separately and mostly to root and tuber crops and to beans and peas.

When the young plants have started growth they are treated with ammonium sulphate, mostly in solution.[3] Here comes the difference between the treatment of leaf crops and root or fruit crops. The leaf crops receive several doses of the treatment, while other crops generally get one or two just to give the plants a good start.

One of the unique features in the method of applying fertilizers in the whole region is the concentration of the fertilizer where it is needed. Instead of being spread all over the field, it is put in holes or furrows previously made for the reception of the plant or seed. The reason is obvious. The fertilizer is placed within easy reach of the roots, thus causing early and vigorous growth. Any treatment that tends to bring this about is desirable in vegetable growing.

[3] One canful (milk can, pint size) of ammonium sulphate is dissolved in one petroleum canful (5 gallons) of water, and this is utilized to water about 100 to 200 plants.

CULTIVATION AND IRRIGATION

Because of the thoroughness of the soil preparation before planting, any cultivation beyond the destruction of weeds is seldom practiced. Irrigation, however, especially during the dry months, is a very important operation. Practically all the crops raised, with the exception of solanaceous crops like the potato, tomato, eggplant, pepper, etc., beans and peas, require much watering for their development. So every garden is provided with an irrigation canal from which water is taken in watering cans. The leaf crops, like cabbage, pechay, lettuce, celery, cauliflower, etc., need to be watered every day during the dry months, until near maturity, when watering is regulated so as to hasten the process.

HARVESTING

All crops are harvested as soon as matured. The harvesting is seldom delayed even if the crop is in no danger of being destroyed. The reason is to have the ground cleared so it can be prepared for another crop, thus keeping the field always occupied with some crops, provided weather conditions permit.

The manner of harvesting depends upon the kind of crop and as to whether it is intended for the local market or for distant shipment. Vegetables for the local market are generally harvested late in the afternoon previous to the market day, or they may be harvested very early in the morning. The object in thus cutting the vegetables as late as possible is to deliver them very fresh. Fresh vegetables of fine quality always sell easier and generally at better prices. Vegetables for long distance shipment are generally harvested in the morning of the day for shipment. These vegetables are put in bamboo crates (Plate 2, fig. 2) when any adhering water has dried up or when the stuff has wilted a little so as to minimize any danger of their rotting while in transit. These are shipped to Manila and other places by rail and by some private transportation companies.

MARKETING

The principal markets of the Baguio and Trinidad gardeners are the cities of Baguio and Manila. Vegetables are also shipped to some big towns like Dagupan, Tarlac, Angeles, San Fer-

nando, etc., but the amount sent to these places is insignificant compared with what is sold in Manila. Tables 3 and 4 give some idea as to the output of vegetables from Baguio and Trinidad Valley, and the months of the year when shipment is heaviest. Data on shipments through private companies were not available but these are believed to be greater than those shipped by the railroad because of lower freight charges.

TABLE 3.—*Monthly shipments of vegetables from Baguio to different provinces per the Manila Railroad Company in 1931*

Province	Month						
	Jan.	Feb.	March	April	May	June	July
	Kilos	*Kilos*	*Kilos*	*Kilos*	*Kilos*	*Kilos*	*Kilos*
Albay	265	297	42	27	20	.....	15
Batangas	.....	16	18	30	135	9	14
Bulacan	145	45	149	1,173	325	18	75
Camarines Sur	.....	.....	.....	.....	130	.....	.....
Capiz	.....	23	.....	.....	.....	.....	.....
Cavite	375	621	433	10	73	.....	.....
Ilocos Sur	.....	83	.....	9	33	.....	30
Iloilo	.....	.....	.....	.....	53	.....	.....
Laguna	392	147	344	549	849	558	316
La Union	365	135	572	442	411	171	336
Manila	70,267	40,410	81,226	63,599	74,607	35,531	31,242
Nueva Ecija	25	36	164	216	186	40	15
Occidental Negros	21	.....	.....	.....	.....	.....	.....
Pampanga	3,545	2,583	4,408	5,310	6,488	4,200	3,549
Pangasinan	771	322	174	378	415	392	379
Rizal	22	26	33	414	221	85	209
Tarlac	3,108	1,929	1,813	2,283	2,604	2,549	2,703
Tayabas	55	15	57	197	597	87	58
Total[a]	9,089	6,278	8,207	11,038	12,540	8,109	7,699

Province	Month					Total
	Aug.	Sept.	Oct.	Nov.	Dec.	
	Kilos	*Kilos*	*Kilos*	*Kilos*	*Kilos*	*Kilos*
Albay	.....	.....	44	26	50	786
Batangas	.....	.....	.....	.....	26	248
Bulacan	13	.....	25	30	611	2,609
Camarines Sur	.....	.....	.....	.....	53	183
Capiz	.....	.....	.....	.....	.....	23
Cavite	.....	.....	.....	.....	.....	1,512
Ilocos Sur	66	18	52	8	44	343
Iloilo	.....	.....	.....	.....	.....	53
Laguna	62	110	211	231	373	4,142
La Union	40	57	225	253	437	3,444
Manila	16,221	9,341	17,767	28,290	59,742	528,243
Nueva Ecija	.....	.....	18	9	52	761
Occidental Negros	.....	.....	.....	.....	8	21
Pampanga	1,096	509	406	1,488	4,200	37,862
Pangasinan	232	69	343	489	615	4,579
Rizal	14	.....	21	45	139	1,229
Tarlac	646	158	451	1,979	1,864	22,087
Tayabas	.....	.....	.....	29	71	1,166
Total[a]	2,169	921	1,796	4,587	8,615	609,291

[a] That to Manila not included in the total.

TABLE 4.—*Comparative monthly and total shipments of vegetables from Baguio to Manila, and to all provinces combined in 1931 and part of 1932.*[a]

Month	Manila			All provinces (railroad)	Total
	Through Manila Railroad	Trinidad Garage	Total		
	1931				
	Kilos	*Kilos*	*Kilos*	*Kilos*	*Kilos*
January	70,267	(b)	70,267	9,089	79,356
February	40,410	.....	40,410	6,278	46,688
March	81,226	.....	81,226	8,207	89,433
April	63,599	.....	63,599	11,038	74,637
May	74,607	.....	74,607	12,540	87,147
June	35,531	.....	35,531	8,109	43,640
July	31,242	.....	31,242	7,699	38,941
August	16,221	.....	16,221	2,169	18,390
September	9,341	.....	9,341	921	10,262
October	17,767	.....	17,767	1,796	19,563
November	28,290	.....	28,290	4,587	32,877
December	59,742	.....	59,742	8,615	68,357
Total	528,243	.....	528,243	81,048	609,291
	1932				
	Kilos	*Kilos*	*Kilos*	*Kilos*	*Kilos*
January	57,458	73,436	130,894	5,186	136,080
February	68,201	64,908	133,109	6,858	139,967
March	94,619	120,900	215,519	12,491	228,010
April	.....	104,982	104,982	.....	104,982
May	.....	140,538	140,538	.....	140,538
June	.....	.....	.....	.....	.....
July	.....	.....	.....	.....	.....
August	.....	.....	.....	.....	.....
September	.....	.....	.....	.....	.....
October	.....	.....	.....	.....	.....
November	.....	.....	.....	.....	.....
December	.....	.....	.....	.....	.....
Total	220,278	504,764	725,042	24,535	749,577

[a] Complete figures for 1932 not presented due to impossibility of getting data from the Railroad Company.

[b] Not available, but shipments by the Trinidad Garage and other companies are believed to have been much greater than those by the Manila Railroad Company; practically all shipped to Manila.

As an aid to more effective marketing, the gardeners in Baguio and in the valley have certain associations. In these they formulate regulations, which, among other things, promote their industry, particularly the selling and buying ends. In 1932, there were three such associations; namely, the Filipino Gardeners' Association, the Japanese Agricultural Association, and the Chinese Gardeners' Association. While these organizations may have some racial tendencies and rivalries, they have arrived at a certain understanding that so far has proved beneficial to their industry. One of their agreements has reference to the

marketing of cabbages, the most important of all vegetable crops raised in the valley.

Because of the great quantities of cabbage produced throughout the whole vegetable season, it was thought necessary to regulate the selling of the commodity so as to prevent any possible glutting of the market with this one vegetable crop. Thus they decided to have two days in a week when cabbages could be sold in quantity. During these days, a gardener is entitled to sell only 25 kilos of cabbage in the Baguio market, but he is free to ship any amount to Manila and other places. This agreement of the three associations has two important features: (*a*) The amount of cabbages that enters the Baguio market is regulated, thus the local price is maintained at a reasonable level; and (*b*) the frequency of placing fresh cabbages on the market, either in Baguio or elsewhere, is limited to twice a week. This enables retailers and agents to sell their old stocks before any fresh lots come in; hence the gardeners as well as the agents and the retailers are reasonably protected.

For the benefit of vacationists, who may leave Baguio any time, the gardeners are at liberty to sell cabbages any day of the week in their own gardens without incurring any penalty, provided the total amount does not exceed 15 kilos a day. Other vegetables raised in the locality can be sold anytime and without any limitations as to amount.

Each association has its agents in Manila. The associations buy seeds and commercial fertilizers in coöperation thus effecting their purchase more cheaply.

CROP ROTATION

While it is universally recognized that crop rotation is one of the major principles upon which successful farming depends, its systematic practice is not much in vogue in the valley, because of the big demand for a few vegetables, and because of the limited area that a gardener works for a living.

In Trinidad Valley and in Baguio any systematic crop rotation is practically relegated to the background. Cabbages occupy the lion's share in the growing of vegetables. Pechay follows. The common cropping method in vogue is continuous planting of cabbages, season in and season out, for a number of years on the same piece of land, though cabbages and pechay may alternate. But while in the latter case there is an actual change of crops, it is not regarded as a rotation because the crops are

of the same family, and they are both leaf and shallow-rooted crops. It is not a rotation that tends to minimize the appearance of repressive agencies nor one that tends to maintain soil fertility.

The effect of this continuous growing of one kind of crop or crops of the same family in the same piece of ground has already manifested itself in the stand of the crops, and the more progressive gardeners have begun to realize it. I have been shown a piece of land that has been cropped to cabbages alone (three crops in a year) during the last twelve years! In this lot more than 50 per cent of the plants died because of various fungus diseases, mostly black leg in the early dry season crop in 1931.

In the poorer sections of certain fields a sort of crop rotation is being practiced, not because the farmers desired it, but because it is necessary. There, the minor crops are raised, and because of their number, and perhaps, because of their climatic preferences, they are planted in a sort of rotation. The gardeners who have the "eyes to see" realize the advantage of this method of cropping, especially in connection with the prevalence of fungus disease that stay in the soil. Such farmers claim that cabbages and potatoes in rotation prove quite advantageous in the control of certain diseases like the black leg of cabbage.

INSECT PESTS AND DISEASES

Because of the intensiveness of vegetable growing there are a number of insect pests and diseases that if not vigorously combated may sooner or later prove fatal to the industry. It is not, however, the purpose of this paper to enumerate all the pests and diseases found in the valley; only the serious ones are mentioned.

Insect pests.—The most important insect pest and the one most intensively fought against is the cabbage worm. It feeds on many plants, but it does the most damage to cabbages and pechay. Fortunately it is not present in abundance during the rainy season when spraying is not practicable.

The pest is controlled by the frequent use of insecticides. The ones commonly used are a preparation of pyrethrum and lead arsenate. The former is a contact poison that is more generally used throughout the region because of its effectiveness, and safety to man as well as to plants, while lead arsenate is usually used when the plants are still small. As long as it is not

washed off, it means less frequency of spraying. However, the moment the plants begin to form heads or even before that, the other kind is used. The claim commonly made as to lead arsenate is that even when the right concentration is used, there is some slight burning of the forming heads, which naturally affects their development. Some observations made by the writer confirmed this claim. Upon drying, a considerable amount of the lead arsenate in the spray collected on the margin of the young leaves, particularly on the forming heads, and this, aided, by the hot sun caused the burning. Where this occurred, the development of the head was affected and naturally its market value. The trouble with the pyrethrum preparation is that its price is high. Derris, a Philippine product, may prove as effective.

During the dry season, when the pest is at its worst, spraying twice a week has been found to be sufficient. Spraying generally ceases when the heads are well formed.

Other insect pests that may be mentioned are flea beetles, which attack plants of the cabbage family, and red spiders, which attack peas.

Diseases.—The fungus diseases, while more numerous are considered by the planters as less destructive. Yet they are, no doubt, causing considerable damage. Foremost among these are the potato and tomato blights. No potatoes will mature properly, and a good crop of tomatoes cannot be had without the judicious use of Bordeaux mixture spray. Other serious diseases are the black leg and soft rot of cabbage, potato scab, tomato wilt, bean blight, and celery blight.

SOME PROBLEMS OF THE GARDENERS AND THEIR NEEDS

While the gardeners seem to be doing well, they have some problems that they cannot well cope with, and problems that sooner or later may arise as an inevitable result of present practices. These need technical men for their proper solution. Perhaps, it is in the solution of these problems that the Bureau of Plant Industry may be of service to the gardeners.

Some of the more important problems are here presented, not that they may soon be studied, but their mere enumeration may serve as a working guide in the formulation of plans for the future activities of the Experiment Station in Baguio, Mountain Province.

Of the more important problems, the following may be mentioned:

1. The use of manures and commercial fertilizers and their application.—The Baguio and Trinidad gardeners may be considered as past masters of the art of gardening. But while they seem to be successful, the questions arise: Are their practices the best and most profitable, and are these not conducive to the development of certain diseases and toxic substances in the soil that may ultimately have ill effects on the crops? In this connection, the writer wishes to bring forth the need for (*a*) a more economical use of fertilizers, (*b*) the most suitable fertilizer or combination of fertilizers for a given crop, (*c*) the amount to be supplied and the frequency of application, and (*d*) the best time to apply such fertilizers. Also, the residual effect of such fertilizers on the crop and in the soil must be determined—whether beneficial or deleterious. In bringing out these points, the writer does not mean to belittle the ability of the gardeners in the use of manures and commercial fertilizers. In fact, one who visits them, particularly the more progressive Japanese gardeners, will invariably find something to learn. But since they are working to make a living in the present, with little or no thought for future years, they are prone to overlook some of the dangers that may ensue as a result of their present practices. Besides, such gardeners cannot afford to test the use of new discoveries that may affect their callings.

2. *Crop rotation.*—In considering the question of crop rotation, three important questions arise; namely, the maintenance of the fertility of the soil, the control of pests and diseases, and the growing of the crop that gives the most net profit.

The present practice, which has been in vogue during the last fifteen to twenty years, is a highly intensive one-crop system. Such a practice must undoubtedly have been the cause of a number of plant diseases and pests that are prevalent in the region. The set of studies in connection with crop rotation should include the possible control of pests and diseases in connection with the growing of the crops that give the most return even considering the expense of maintaining soil fertility. This last factor can properly be met with the use of suitable fertilizers.

3. *Insect pests and diseases.*—The success of vegetable growing in Baguio and in Trinidad Valley is predicated upon the ef-

fective control of pests and diseases. This is especially true of the cabbage and its relatives, Irish potatoes, tomatoes, peas, etc. On the control of the cabbage worm, the black leg and soft rot of cabbage, the potato and tomato blights, potato scab, red spiders, etc., will depend the future of the vegetable industry in this region. These matters need serious consideration. The point may be raised: Is it not possible to completely eradicate the cabbage worm from the region—a valley surrounded by forests and away from outside sources of infection?

4. *The seed and its production.*—In the discussion of this topic, seed is classified into imported seed and home-grown seed. The vegetable industry in Baguio and in Trinidad Valley will always, perhaps, depend partly upon imported seed. The production of cabbage seed and some of its relatives and the storing of potato seed tubers are still problematical. Some isolated attempts in the Mountain Province have produced cabbage seeds, but such seeds were found to be poor. However, it is now definitely known that there are only a few favored places in the world where good quality cabbage seed can be produced. As to Irish potatoes, there is still the possibility of raising seed tubers during June and July in certain sections of the Islands. There is also a strong indication of the possibility of naturalizing an exotic variety in the Mountain Province. The Spanish potato has been grown in the Mountain Province since the Spanish regime. This variety may be used as a basis of breeding work on potatoes. Work on the acclimatization of foreign varieties may be fruitful of good results.

In connection with seed potatoes that the local gardeners will have to import,—the variety or strain among the imported kinds that will be best suited to local climatic and soil conditions must be ascertained. In the present stage of the seed industry in the United States and in some other countries, it is possible to obtain the history of the seeds that are sold. Seeds of known history can be imported, these tried here and the kinds best adapted to certain sets of conditions ascertained. Some arrangement could be made with the institutions or companies that produce the seed found best under local conditions so that they will produce all that is needed every year. The Bureau of Plant Industry, as in the case of Bermuda onions, may undertake the buying and selling of the seeds. In this way, the quality of the seed will always be assured, and if need be, the seeds can be properly disinfected before being sold.

With respect to home-grown seed, the best variety or strain of each crop should be selected, either through acclimatization, variety test, or line selection. Hybridization can be resorted to to evolve new varieties or strains. In this particular field, there are great opportunities for the local plant breeders to produce varieties or strains that will suit the varied conditions in the valley and in the whole country.

SUMMARY AND CONCLUSIONS

1. This study was conducted for about two years. Observations were made throughout the year on the practices among the Japanese, Chinese, and native gardeners in Baguio and in Trinidad. Private gardeners and others who have lived long in the region were interviewed.

2. The vegetable industry in Trinidad Valley and in Baguio was primarily the direct result of the work of the former Baguio Experiment Station established in 1903 in Trinidad Valley by the old Bureau of Agriculture. The Trinidad Agricultural School, which followed the experiment station, as well as the Japanese and Chinese gardeners, had their due share in bringing the industry up to its present level.

3. The region enjoys a more or less semi-temperate climate and is adapted to the growing of temperature and semi-temperate crops. The principal crops are cabbage, pechay or Chinese cabbage, beans, strawberries, green onions, peas, Irish potatoes, sweet potatoes, celery, beets, cauliflower, etc. Cabbage constitutes about three-fourths of the total vegetable crops.

4. The vegetable industry is both extensive and intensive. All of Guisad and Lucban Valleys in Baguio, and the suitable areas for vegetables in Trinidad Valley are devoted to vegetable growing. The total area was estimated to be over 200 hectares in 1932, and practically all of this area was under some crops of vegetable throughout the year.

5. Besides the natives, Japanese and Chinese constitute the rest of the gardeners. The last two are tenants, paying from 150 to 300 pesos per hectare per annum. They are, however, the more progressive, especially the Japanese, and they have larger gardens.

6. Manual labor is the sole source of power in the preparation of the soil for planting. The Japanese hoe is the most important tool in the valley, and it is used for digging and pulverizing the soil, and in making holes for the reception of the seed or

plant. The natives from different parts of the Mountain Province supply most of the labor. The daily wage is from 60 to 80 centavos with food, but the laborer has to work from daybreak until dusk.

7. The raised bed method is employed throughout. This method makes the thorough working of the soil easy, provides excellent drainage even during the rainy season, and leaves paths between the plots. Thus the areas devoted to plants are never stepped on nor compacted.

8. Most of the seeds planted are imported, principally from the United States, Japan, and China. Beans, peas, tomatoes, peppers, and a few species are generally propagated from seeds produced locally.

9. The success of the gardeners in Trinidad Valley and in Baguio is attributed mostly to (*a*) the thorough preparation of the soil; (*b*) the liberal application of stable manures, decayed crops residues, ashes, and commercial fertilizers; (*c*) good control of many of the more important pests and diseases with the use of insecticides and fungicides; (*d*) the liberal use of irrigation water; and (*e*) industry, diligence, and coöperative spirit of the gardeners.

10. Very little rotation, if any, is being done by the gardeners; the practice in vogue is mainly a one-crop system. Gardeners, however, are beginning to realize the bad effects of such a method of cropping in spite of the liberal use of commercial fertilizers and organic matter.

11. Some of the most important pests and disease are cabbage worms, cut worms, red spiders, potato and tomato blights, potato scab, black leg and brown rot of cabbage, and blight of celery.

12. The gardeners have formed coöperative associations. The selling of cabbage is regulated so that there are only two market days for cabbages a week. A gardener may sell 25 kilos of cabbage in the Baguio market and may ship any amount to Manila and other places on market days. The purchase of seeds and commercial fertilizers is generally effected through the associations.

13. Baguio and Manila are the principal markets of the Baguio and Trinidad Valley grown vegetables. Considerable quantities are also shipped to Pampanga, Tarlac, Pangasinan, La Union, Nueva Ecija, and some other provinces.

ILLUSTRATIONS

Plate I

Fig. 1. Portion of the vegetable gardens in Trinidad Valley. In the foreground is a rainy-season cabbage crop just harvested; in the background are dry-season cabbage crops. Raised beds can be seen in the harvested portion of the field.

2. An Irish potato field in Trinidad Valley. An irrigation canal is shown in the foreground, and a compost building on the right.

Plate II

Fig. 1. Low glasshouses for raising seedlings in Trinidad Valley.

2. Crated vegetables (mostly pechay or Chinese cabbage) ready for shipment to Manila.

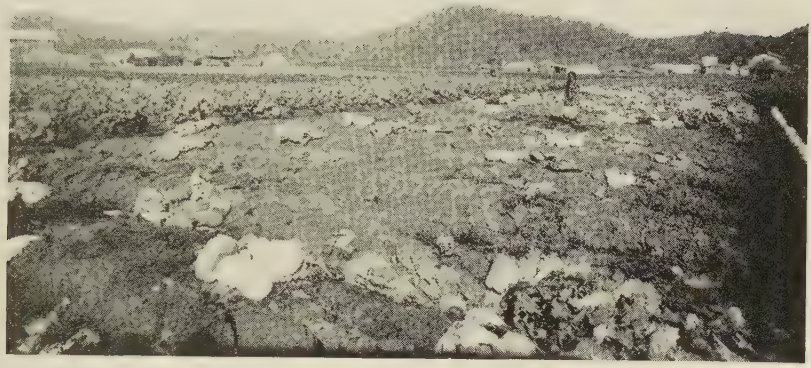

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PLATE I

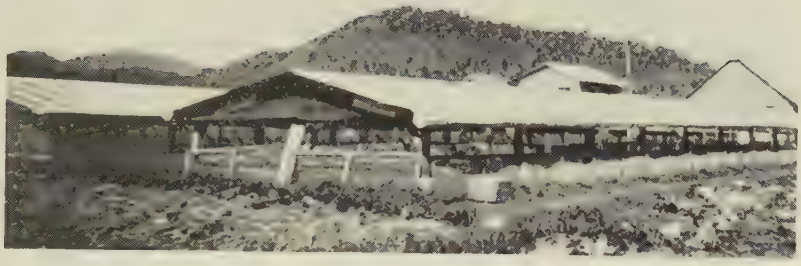

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PLATE II

STUDIES ON THE REFINING OF PHILIPPINE HONEY

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ONE TEXT FIGURE

Honey, as defined by the United States Department of Agriculture, is the nectar and saccharine exudations of plants, gathered, modified and stored in the combs by honey bees (*Apis mellifica*), is levorotatory, contains not more than 25 per cent of water, with more than 0.25 per cent of ash and not more than 8 per cent of sucrose. The above definition limits the term to the saccharine product through the agency of a definite species of the bee, *Apis mellifica;* thereby excluding the wild Philippine honey from the narrow meaning of the term honey. In the Philippines, attempts to produce honey with *Apis mellifica,* particularly the famous Italian variety (Otanes, 1926), have been made but these attempts never went beyond the experimental and laboratory stage. As far as the authors are aware, the literature, except the circular of Otanes, 1926, is conspicuous by the absence of studies dealing with honey and beekeeping.

According to statistics prepared by the Division of Statistics of the Department of Agriculture and Commerce, the Philippines is importing honey to the value of about 8,000 pesos [1] yearly for direct consumption and for medicinal and confectionery purposes.

In some provinces, particularly Zambales, Bataan, Bulacan, and Rizal, wild honey is collected and may be bought in the local markets or from peddlers.

USES

In ancient times and before the manufacture of sugar was known, honey was the only source of sugar. Then it was a delicacy. Among the Hindus, fresh honey was used as a laxative, and honey that was a year old was used as an astringent.[2] In various countries, honey had its characteristic uses. The *ce-*

[1] One peso Philippine currency equals 50 cents United States currency.
[2] N. C. Dutt., Mat. Med. of the Hindus 1877.

romel of India, for example, made by mixing one part of yellow wax with four parts of fresh honey, was used as mild stimulant in the treatment of ulcers, instead of oils and fats, which grew rancid. In old England, *mead,* a favorite beverage, was made by the fermentation of a liquor obtained by boiling the combs from which the honey was drained. A modification, *sack* or *mead,* had hops in addition to the liquor, to which brandy was added after the fermentation. *Metheglin* or *hydromel* was made by yeast fermentation of a solution of honey with hops. The old Roman *mulsum* was honey, wine and water boiled together. During the time of Chaucer, there was *clarre* or *piment,* a strained solution of honey, wine, water and spices. Among the Arabs, cream or fresh butter with honey was and still is a delicacy eaten with or without bread. Among its other uses may be mentioned that as an embalming agent in Egypt, as purificatory among the Hindus, whereby honey is placed in the mouth of a new-born male infant, and that as a preserving material for shipments of fruits, seeds, and eggs.

In Europe and America, there has been a revival of interest in the use of honey as a part of the diet. The increasing use of manufactured sugar, and the keen interest in the properties of vitamins have led many to advocate the use of honey because of its mineral, nitrogenous, and vitamin contents, which are quite lost in the sugar in the process of manufacture. And although artificial honey can be processed, the composition is at variance with that of genuine honey.

SOURCE AND COMPOSITION

In the United States and in many countries of Europe, notably Hungary, Germany, Poland, Italy, and the Balkans, the production of honey in apiaries is an established trade. In the neighborhood of the Palestine countries—"the land flowing with milk and honey"—the gathering of honey is a source of revenue for the people. In the United States, beekeeping is a science and an art, and the Government lends aid to the industry. In the Philippines, however, honey is simply gathered in the forests.

In apiaries, three recognized classes of honey are gathered; namely, the comb honey or that drained from the comb; extracted honey or honey forced out of combs by centrifugal separators, and shunks, or mixtures of the two. In addition may be mentioned strained honey, gathered by pressing the honey out of the comb and straining until clear.

In the Philippines, as elsewhere, where honey is gathered in the forests, the bees are driven away when the combs are overflowing and preferably before the new brood is started and the honey gathered. The colony is generally smudged in order to drive out the bees.

The locality, season, method of beekeeping, strains of bees, and bee food influence the character of honey. In the United States apiaries in buckwheat fields produce black honeys that are very strong flavored; clover honeys are light in color and alfalfa honeys are amber; the last two are mild in flavor. Heather honey is dark golden yellow; honey from honey-dew is dark. Orange blossom honey has a very fine aroma. The famous Narbonne honey of France is from apiaries in thyme and mint gardens. The Russian *lipez* is honey from linden.

As regards composition, honey is a supersaturated solution in a noncrystallizable sugar of these materials: levulose, dextrose, sucrose, dextrin, gums, ash, pollen grains, beeswax, albuminoids, free acids as malic, chorophyll derivatives, as carotin and xanthophyll, enzymes as invertsase, diastase, amylase, castalase, imulase, aromatic bodies, and vitamins A, B, and C.

Table 2 shows the composition of foreign honeys compared with the average of four samples of Philippine raw honey. There is a decided excessive water content in Philippine honey, and a lack of sugars. It may also be stated that the quality is inferior, fermentation being active in the honeys used in this study.

The samples of Philippine honey were received in old and rusty kerosene cans. The samples were extremely dirty, the dirt consisting of mud, leaves, rotted combs, wax, bodies of dead insects, pieces of jute, and small stones. Granulation was very apparent, some crystallized dextrose being as large as a seed of corn, the crystals being clustered together at the bottom. There was also a frothy scum on top where the insect bodies were floating. Samples capped in bottles without sterilization soon exploded, due to gas during fermentation. The acidity is in fact formic as shown by analysis to be higher than normally expected.

There was also a good deal of suspended matter which made it lack clarity. The collector of the samples stated that they were over a year old. This might account for the fermentation by sugar-tolerant bacteria, the higher acidity, and the scum on top.

It has been established that spoilage may ensue during the storing of honey, caused by the fermentation by sugar-tolerant bacteria. The activity of these bacteria is related to a critical moisture content, about 20 per cent moisture being the limiting line. Long storage, especially of unripe honey, tends to increase moisture, first because of the inherent hygroscropic quality of honey, and second because of the crystallization of dextrose, with one molecule of water of hydration, thus causing the increase in moisture of the non-crystallized portion of the honey.

The black color of three samples analyzed was due probably to natural quality, and partly to the incorporation of soot during smudging and subsequent pressing, and possibly to adulteration with mud and molasses.

The invert sugar was analyzed by the Eynon and Lane method; the water by Brix, the ash by open incineration, according to the Hawaiian methods of sugar analysis, and the acidity by titration with standard alkali, using phenolphthalein.

REFINING OF THE HONEY

The refining of the honey samples presented the following problems: (*a*) The cost of refining had to be low in order that the finished product might be economically marketed; (*b*) the flavor and taste had to be preserved; (*c*) the color had to be reduced to that of ordinary market honey.

All the samples of raw honey were diluted to from 40 to 60° Brix for clarification and decolorization. The following methods were used.

1. *Use of the supercentrifuge (laboratory model).*—The honey sample was diluted to approximately 60° Brix and given the following treatments:

(*a*) 1.5 per cent of celite.
(*b*) 3.5 per cent of celite.
(*c*) 1.5 per cent of Kieselguhr.
(*d*) 1.5 per cent of super cel.
(*e*) 1.5 per cent of Spanish clay.

It was found that at 60° Brix, the mixture could not rise up the centrifugal separator, so that the total solids were reduced to 40° Brix. At this dilution, the liquor flowed out of the first discharge (clarifier) but did not separate well. All the centrifuged samples were turbid, due to the suspension of the filter aid.

Excessive dilutions of the honey were not used because the water thus added had to be evaporated again, and every additional quantity of water added would mean additional time and expense of evaporation.

2. *Use of vacuum filtration.*—For honey samples treated at about 45° Brix, attempts were made to effect filtration by the use of a vacuum. A Buchner funnel 6 inches in diameter was attached to a heavy 1-liter suction flask to which was attached a train of two receivers. The filtering media were:

(a) *Asbestos.*—Asbestos prepared for Gooch crucibles was used but this did not give satisfactory results. It was found to be expensive, due to the large area of the Buchner funnel and the fact that it could not be used repeatedly. Aside from this, it was observed that the pores of the Buchner funnel were too large to retain the small fibers, which went into the filtrate; and even if the liquor was filtering clear, at every disturbance of either the vacuum or the feed, asbestos fibers would go into the filtrate and necessitate refiltration. Coating the asbestos mat with a precoat of filter aid did not help any.

(b) *Cloth-filter aid layer.*—The cloth used was ordinary broadcloth cut to fit the Buchner funnel. At first two layers were used; later, only one was employed. The cloth was put in place with the help of water and a layer about 3 millimeters of filter aid was deposited on top. The filter thus prepared was washed free of siliceous material that could be washed down, and used before caking occurred. Caking, due to drying, of the pre-coat of filter aid caused cracks; and the closely packed filter material hindered rapid flow.

The following were qualitative tests:

(1) *Four per cent Spanish clay.*—The filtrate was quite turbid; without change in color. The filter clogged easily. The reason seems to be that the particles of Spanish clay are not uniform in size, and the small ones went into the spaces between the longer ones leaving minute pores or none at all through which the liquor could pass.

(2) *Ten per cent Spanish clay, heated.*—Heating to 60° C. for ten minutes improved the filtering quality somewhat but the color did not get lighter.

(3) *Five per cent Kieselguhr, heated ten minutes at 50° C.*—There was no change in color with two samples, but the clarity was greatly improved.

(4) *Use of decolorizing carbon.*—There was one sample (Raw 4) which could be refined easily and be decolorized to pale yellow. For this sample, without using carbon, the color of the filtrate was dark reddish orange, but was clear and brilliant. For the other samples, however, as much as 20 per cent carbon had to be used, yet it did not materially lighten the color. This seemed to be due to the dirt so closely incorporated with the honey that separation was extremely difficult.

Qualitative tests with the following were made:

(1) Ten per cent decolorizing carbon without filter aid—the filtrate had within it suspended particles of carbon, giving the liquid an ash color; the carbon suspension later settled, but settling was imperfect. Even qualitative filter paper could not hold out the carbon particles of small size.

(2) Two per cent filter aid (Standard Super-cel) and 2 per cent carbon, heated to 60° C. gave good results. This procedure was finally the method adopted, varying the quantity of both carbon and filter aid depending upon the color intensity and turbidity of the syrup.

When the honey was decolorized in this manner, there was an increase in the invert sugars by about 8 per cent due to the removal of suspended matter mostly, and to colloids. It is also possible that heating may have affected some constituents which influence the method of analysis used for invert sugar. The ash also decreased, but the decrease was not much, pointing to the possibility that some of the very fine particles of the filter aid went with the filtrate.

Time and velocity of filtration.—In order to secure balance with the rate of evaporation in an attempt to define a continuous process, the rate of filtration was roughly adjusted. Varying amounts of filter aid were added, and at the same vacuum and the time necessary to filter 3 liters were noted. It was observed that the addition of 0.5 per cent filter aid was not enough to prevent early clogging of the filter used, and that the addition of 1.5 to 10 per cent filter aid gave better results, and varying the amount with the observed turbidity of the sample, the rate was on the average of 6 liters in five hours. The rate seemed to depend upon the precoating of filter aid. A thin precoating caused early clogging, while a thick precoating caused filling up of the funnel with the filter aid. Therefore, a precoat of about 5 millimeters was used throughout the experiment.

Heating to various temperatures was also done. The limits of heating found were ten minutes at 40° C., at which the effect

of the decolorizing carbon was nil, and ten minutes at 80° C., when the syrup darkened even with the addition of sodium carbonate to partially neutralize the acid.

The final heat treatment followed was made at 10 to 15 minutes at 50 to 60° C., never exceeding 65° C.

Another consideration in heating is the loss of volatile matter that makes up the flavor and part of the taste. As was observed, the higher the temperature to which the syrup was heated, the less tasty the resulting syrup is, and even at sterilization temperature, 70 to 75° C., a great deal of the volatile matter is lost, there being a very perceptible difference in the aroma of sterilized and nonsterilized samples from the same stock.

Evaporation.—The decolorized samples were boiled under vacuum to about 75 to 78° Brix. The apparatus, in the final form, is as shown in the sketch. The limiting factor was the capacity of the suction pump, and it was found that at normal tap water pressure this could take care of about 2 kilograms of water vapor at temperatures not exceeding 55° C. and a vacuum not lower than 27 inches, in seven hours. Therefore, the output of the evaporation was about 1 liter per hour when working continuously and in balanced operation. The thick honey was drawn out and dumped into museum jars where two or three charges could be mixed in each before bottling. This was done to make the product similar in every bottle. About

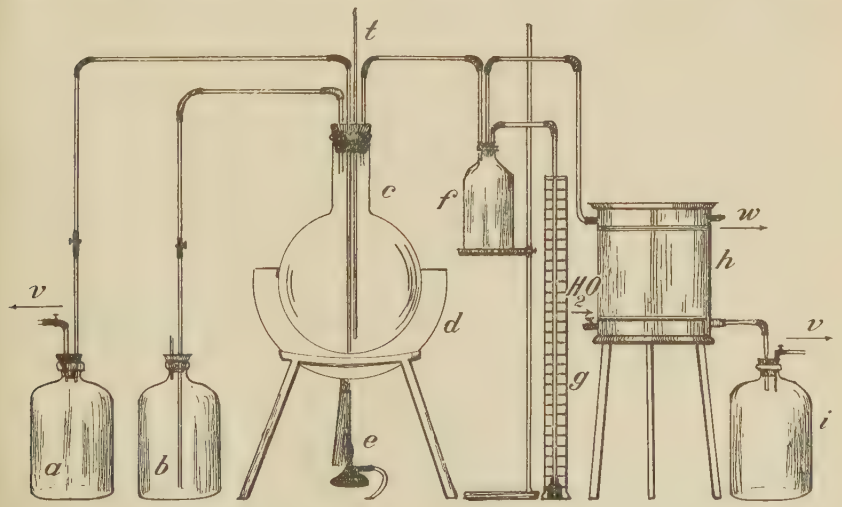

FIG. 1. The assembly of apparatus used for concentrating the diluted and decolorized honey (under vacuum). *a*, Receiver for concentrated honey; *b*, bottle for diluted honey (feed bottle for evaporation); *c*, evaporating flask; *d*, water bath for heating evaporator; *e*, gas burner; *f*, entrainment trap; *g*, mercury manometer; *h*, coil condenser; *i*, distillate receiver; *t*, thermometer; *v*, vacuum; *w*, water.

four grades were produced. The honey was bottled; the bubbles were removed, partly by vacuum and partly by overflow; some bottles were sterilized; some were sealed at once.

The following observations relate to the working of the evaporation:

1. A part of the flavor of the honey was apparent in the condensate. Therefore, the condensate was used as the diluent. This procedure somewhat reduced the loss of aroma in the honey.

2. The flavor and the odor of the honey in this process of refining were ultimately related to the degree of decolorization: the greater the degree of clarification, the more aromatic honey odor and flavor had been removed. Since it is required to produce refined honey of the best flavor possible and having an odor nearest to the original raw honey, the refining could not be carried far enough to get the clarity of commercial-grade honey.

3. Some bottles of the refined honey showed reddening or browning at the top. This may have been due to the colloidal suspension floating where the lightest portion of the honey is, and to oxidation (Cruess) on that place in the surface.

4. The first portion of the honey drawn into the evaporators stays in these for about six hours or until the charge is drawn out. The prolonged heat treatment may modify the character of the honey; especially during the last stage of evaporation where, due to the concentration and viscosity of the syrup, the stirring was insufficient for thorough mixing.

COST OF REFINING

Table 4 shows the cost of refining the honey in the laboratory. The cost can be greatly reduced if the decolorizing carbon can be reclaimed by incineration out of contact with air, as is done in sugar refineries. The use of properly designed evaporators and preheaters [1] is also important.

The price of honey in the United States during normal times is about 10 cents per pound. It is manifestly impossible with present methods to compete with American honeys, except those that are packaged in fancy style.

SUMMARY

The usual grade of raw Philippine honey as commonly bought in the markets is dirty and quite frequently in a fermenting stage. The dirt usually consists of black suspended material,

[1] Elec. World 88 (1926) 1123–24.

dead bees, leaves, twigs, and mud. The suspended material cannot be removed by ordinary filtration. Even the best grade of raw Philippine honey cannot be used for confectionery purposes. After refining, this same honey has been found to be satisfactory.

Filtration of diluted honey with the help of filter aids effects clarification to a certain extent. Due to colloids and other suspended matter, the filtration is very difficult.

The use of decolorizing carbon decolorizes honey with different degrees of facility. Some samples of raw honey can be decolorized more easily than others.

Heating removes a goodly portion of the aroma of honey. Prolonged heating at high temperatures darkens the color. It seems that the characteristic taste and odor of Philippine honey varies with the extent of refining; that is, the greater the degree of clarification, the more aromatic odor is driven off.

The laboratory method of refining honey is too expensive. If done on a large scale and with cheaper decolorizing carbons similar to those used in the refining of sugar, the cost of refining would be greatly reduced.

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TABLE 1.—*Quantity and value of honey imported into the Philippine Islands*

Year	Quantity	Value
	Kg.	*Pesos*
1928	13,466	10,332
1929	14,640	10,455
1930	9,289	6,594
1931	12,823	6,263
1932	.....	4,951
Average	.....	7,719

TABLE 2.—*Showing chemical composition of Philippine raw and refined honey compared with that of foreign honeys*

Origin	Water	Invert sugar	Sucrose	Ash	Dextrin	Acid	Source
America	17.70	74.98	1.90	0.18	1.51	0.08	Browne.
Cuba	21.07	71.77	0.94	0.22	1.43	0.14	Bryan.
Mexico	21.04	72.30	0.80	0.25	1.45	0.19	Do.
Haiti	22.02	73.73	0.55	0.16	0.53	0.12	Do.
Spain	20.60	72.88	1.76	0.25	1.69	.....	Encyclopaedia Universal.
Philippines; raw	28.90	58.56	.....	0.35	.....	0.19	Analyzed.
Philippines; refined	25.97	66.97	.....	0.28	.....	0.20	Do.

TABLE 3.—*The chemical composition of raw and refined Philippine honeys*

Sample	Brix	Invert sugar	Ash	Acid	Color	Turbidity at 50° Brix
	°					
Raw 1	68	55.64	0.43	0.216	Black	10
Raw 2	71.5	57.24	.....	.....	....do	10
Raw 3	70	56.46	.....	.....	....do	10
Raw 4	75	64.92	0.27	0.166	Burnt red	10
Filtered 1	50	44.65	.....	.....	Clear red	80
Decolorized 1	75	67.64	.....	0.207	Clear reddish orange	103
Decolorized 2	73	66.24	.....	.....	Clear red	114
Decolorized 3	75	67.03	0.28	.....	Bright yellow	142
Filtered from raw 4	50	.....	.....	0.179	Dull burnt red	80

TABLE 4.—*Observations on clarification of Philippine honey*

Original sample			Filter aid		Heating		Decolorizing carbon [a]
Brix	Color	Turbidity	Name	Quantity [a]	Temp.	Time	
°					°C.	Min.	
40	Burnt brown	Very turbid	Celite	1.5			
40	do	do	do	3.5			
40	do	do	Kieselguhr	1.5			
40	do	do	Super cel	1.5			
40	do	do	Spanish clay	1.5			
40	do	do	Super cel	2	60		
50	do	do	do	1.5	60		
50	do	do			60	30	10
50	do	do	Spanish clay	4			
50	do	do	do	10	60	10	
50	do	do	Kieselguhr	5	50	10	
50	do	do	Super cel	2	70	5	2
50	do	do	do	2	60	10	2
40	do	do	do	2	60	10	2
40	do	do			80	5	2
40	Reddish brown	Turbid	Super cel	2	65	10	2

Orginal sample			Treated sample		Method of separation	Filtering rate	Remarks
Brix	Color	Turbidity	Clarity	Color			
40	Burnt brown	Very turpid	Turbid	No change	Supercentrifuge		
40	do	do	Very turbid	do	do		
40	do	do	Turbid	do	do		
40	do	do	do	do	do		
40	do	do	do	do	do		
40	do	do	do	do	Asbestos mat	Slow	Filter easily clogged.
50	do	do	Little turbidity	do	Cloth filter	Two-thirds liter per hour	
50	do	do	Carbon suspension		Sugar filter paper	Very slow	No filter aid.
50	do	do	Turbid	No change	Cloth filter	Clogged early	
50	do	do	Little turbidity	do	do	Moderately fast	Funnel filled.
50	do	do	Clear	do	do	One-half liter per hour	
50	do	do	do	Brownish yellow	do	do	
50	do	do	do	do	do	do	
40	do	do	do	do	do	Two-thirds liter per hour	
40	do	do		Black			
40	Reddish brown	Turbid	Clear	Bright yellow	Cloth filter	do	

[a] Expressed as per cent by weight of syrup.

TABLE 5.—*Cost of refining raw honey in the laboratory. Cost per kilo of 73–75° Brix*

	Page
Filter aid	0.01
Decolorizing carbon [a]	0.12
Gas	0.12
Water	0.05
Total	0.30
Cost per pound	0.14
Cost per liter	0.40

[a] The cost can be very greatly reduced if the decolorizing carbon is reactivated or steam is used instead of city gas. Decolorozing carbon (Germann and Co.) cost 1.30 pesos per kilo.

ILLUSTRATIONS

TEXT FIGURE

FIG. 1. The assembly of apparatus used for concentrating the diluted and decolorized honey (under vacuum).

a, Receiver for concentrated honey.
b, Bottle for diluted honey (feed bottle for evaporation).
c, Evaporating flask.
d, Water bath for heating evaporator.
e, Gas burner.
f, Entrainment trap.
g, Mercury manometer.
h, Coil condenser.
i, Distillate receiver.
t, Thermometer.
v, Vacuum.
w, Water.

PREPARATION OF VINEGAR FROM PHILIPPINE FRUITS AND OTHER SACCHARINE MATERIALS

By F. T. Adriano and H. L. Ylizarde

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Vinegar has been defined as a "condiment produced by the successive alcoholic and acetic fermentation of a watery solution of sugar or starchy substances containing yeasts and bacteria." It comes from the French words "vin aigre" meaning sour wine. Its use as a food commodity is universal.

The European and American standard vinegars are prepared from apple and grape juices. Recently, however, vinegar has been made from other temperate as well as subtropical fruits, such as pears, peaches, persimmons, oranges, watermelons, berries, and bananas. In the Philippines vinegar is made from the toddies of nipa, coconut, buri, and cabo negro, and from sugar-cane juice.

The seasonal occurrence of many fruits in the Philippines has created problems of varied interest and importance among the farmers, the most neglected of which is perhaps how properly to utilize the great amount of waste of fruits that accompany each harvest. Aside from the tuba, nipa, and other palm toddies as the usual local sources of vinegar, different varieties of bananas and fruits have been found to contain high fermentable sugars, which render them fit for wine and vinegar making.

The waste consists principally of fruits that cannot be profitably marketed, due to bruises caused by mishandling or overripeness; or that, because of oversupply, cannot be sold at profitable prices in the local markets.

The value of vinegar imported into the Philippines during five recent years is shown in Table 1.

Table 1.—*Value of Philippine vinegar imports from 1927 to 1931*

Year	Liters	Pesos
1931	75,300	14,584
1930	55,180	10,557
1929	58,827	14,116
1928	86,141	19,239
1927	73,765	16,863
Average	69,765	15,152

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This importation could be greatly diminished if in many homes vinegar could be properly made from fruits and juices heretofore thrown away as waste.

USES OF VINEGAR

The importance of vinegar as an article in food preparation and preservation cannot be overestimated, as it is used in seasoning foods prepared from meat, fish, and vegetables of all kinds. It is indispensable in the household.

Vinegar is a constituent of high-quality catsups, salad dressings, mayonnaise (sometimes), prepared mustard, and many sauces. It helps in preventing foods from spoilage.

Vinegar has a place of its own in the pickling industry. Pickles of different kinds are good appetizers and for their preparation vinegar is the most important ingredient.

REVIEW OF LITERATURE

Von Loesecke (1929) reported that bananas contain on the average about 16 per cent fermentable sugars. The alcohol content during fermentation varies from 6.55 to 10.12 per cent. The banana vinegar obtained by the Orleans process was light amber in color and possessed an agreeable aroma and taste.

Van Slyke (1904) reported that the alcoholic fermentation of cider kept at a cellar temperature of 7.2 to 12.7° C. was completed in about five to six months. The acetic acid fermentation then followed and was complete in a period varying from fifteen to twenty-four months. It was concluded by Van Slyke that the acetic fermentation proceeded more rapidly and satisfactorily at a temperature ranging from 10 to 32.2° C. than from 7.2 to 18.3° C. A total acid content of from 4.3 to 7 per cent was obtained in six months, but the results were not uniform. It was also concluded that adding "mother of vinegar" when the alcoholic fermentation was about complete hastened the completion of the acid fermentation. There was a loss of acetic acid in old vinegar which resulted from contamination with organisms that destroy the acid in the presence of air.

Lamb and Wilson (1923) demonstrated that with apples it is possible to make good cider vinegar in twelve months or less. In many cases the vinegar reached a marketable strength in less than six months. They have further shown that the alcoholic fermentation is nearly made complete in one month or less and the formation of acetic acid begins in two or three weeks after the juice is pressed from the apples.

Adriano and Banzon (1931), in their work on the preparation of vinegar from fruit juices and palm toddies, found that the Latundan variety of banana contained over 5 per cent acetic acid and possessed a very pleasing aroma. They further demonstrated that the vinegar from water of immature (*buco*) coconuts contained about 1 per cent acetic acid; the nipa vinegar commonly sold in the local stores, 2 per cent; and artificial vinegar now commonly sold everywhere, 4 per cent.

OBJECT OF THE WORK

The present work has for its object the determination of the proper methods of preparing vinegar from fruits and juices that abound in many places and can furnish cheap raw materials for this product. The work has not been carried beyond the laboratory scale but could be expanded to commercial scale production.

PRINCIPLES INVOLVED IN THE PREPARATION OF VINEGAR

ALCOHOLIC FERMENTATION

The process consists in the conversion of the sugar into alcohol and carbonic acid gas, through the action of the microscopical one-celled plants called yeasts.

The following reaction takes place when the sugar of the fermenting solution is acted upon by yeasts:

$$C_6H_{12}O_6 + \text{Yeasts} = 2C_2H_5OH + 2CO_2$$

Chemically, this means that 100 parts of sugar should give theoretically 51 parts of alcohol and 49 parts of carbon dioxide; whereas practical tests show a yield from 48.5 to 50 parts of alcohol.

The fruit mash is treated with commercial yeast that has been mixed with a small portion of the juice. The receptacle is covered with a layer or two of cheesecloth to prevent the entrance of insects. During fermentation the mash is stirred daily to prevent mold formation and insure a more complete fermentation. The action of acetic bacteria is also prevented by stirring. Three or more days are necessary for this fermentation.

The fermented juice is separated from the mash by filtration through a piece of cheesecloth. Complete separation requires the use of a hand press. The alcohol content is determined according to the methods of the Association of Official Agricultural Chemists (1930). The alcohol test is not essential and is

seldom made except in the laboratory and in the commercial production of vinegar.

ACETIC FERMENTATION

After the fermented juice has been returned to the jar or barrel, a starter in the form of strong, fresh vinegar is added in the proportion of 1 part to 4 parts of the fermented juice and the receptacle covered with cheesecloth.

The addition of vinegar will introduce sufficient acetic bacteria to promote the acetification. The rapid development of bacteria produces a slimy skin or film known as "mother of vinegar." This coating is essential for a successful fermentation and it will form and settle as long as any alcohol remains in solution.

The following show the changes that take place during acetic fermentation:

$$\underset{\text{Alcohol}}{C_2H_5OH} + O = \underset{\text{Aldehyde}}{C_2H_4O} + H_2O$$

$$C_2H_4O + \text{acetic bacteria} + O = \underset{\text{Acetic acid}}{CH_3COOH}$$

The alcohol is changed by oxidation into a product called aldehyde (acetic aldehyde) and the aldehyde is acted upon by the acetic bacteria to form acetic acid.

The vinegar fermentation is carried on by one or the other of the following described processes:

Slow process.—Of the so-called slow processes, the Orleans method of acetification is the best. This process is carried on in barrel containers holding about 100 or 150 liters and it takes several months to complete the fermentation. The barrels should be filled about three-quarters full. Bungholes, about an inch in diameter, should be bored to permit the free circulation of air. They should be screened with woven wire or cheesecloth to keep out insects. The barrels should not be disturbed during the acetous fermentation. The vinegar is allowed to stand until it has reached its maximum strength. Approximately three-fourths of the prepared vinegar can be drawn off and to the remaining fourth newly fermented and settled juice can be added to start a new acetic fermentation.

Generator process.—The greater the amount of air supplied to the vinegar bacteria, the faster is the rate of vinegar fermentation. Therefore, the rate of acetification is increased when more oxygen is introduced by using the so-called generator process.

Two types of generators are in use. The first is the "tank generator," which is provided with false bottoms, containing

beech-wood shavings, birch twigs, corn cobs, or other inert woody materials, previously saturated with old vinegar, through which the alcoholic liquor percolates and is brought in contact with a current of air introduced from below.

The other is called the "rotating generator," which is provided with false bottoms, containing the alcoholic liquor into which dip slowly revolving drums containing beech shavings. In the former process the acetification is completed in two or three days; in the latter, in about four weeks.

AGING

The highest quality of vinegar is attained by storage from six months to a year or more. During storage the biting taste of a new product is turned mellow, the esters are formed, and the flavor and aroma of good vinegar become distinctly apparent.

CLARIFICATION

Racking off the liquid.—The vinegar is "racked off," that is, drawn off carefully, after several months of storage, so as not to disturb the sediment and with as little exposure to the air as possible. This is satisfactorily done with the use of a siphon. Ordinarily, the yield is clear and fit for home use but when intended for sale it should be clarified.

Filtration.—Filtration of vinegar is the most common method of obtaining a clear product.

The liquid is passed through a filter made by folding a piece of canton flannel or cheesecloth into two or three thicknesses. The efficacy of all filters depends upon the gradual filling up of the pores of the filtering medium by particles of the material passing through it. Perfect clarification is accomplished only by repeated filtration.

Clarifying agents.—Some clarifying agents used in securing a clear or bright product are the "Standard Super-cel," Spanish clay, Kieselguhr, etc.

Kieselguhr, a compound of silica, is applied at the rate of from 0.75 to 1.0 per cent of volume of the highly colored liquids.

Spanish clay and the "Standard Super Cel" are applied in varying amounts from 0.75 to 1.5 per cent of the volume of more or less light colored liquids.

After treatment with clarifying agents, the mixture is heated to 60° C., settled, and filtered.

Clarifiers are substances which facilitate the removal of suspended matter in the turbid liquid. They are porous, light in

weight, inert, and do not affect the physical or chemical characteristics of the filtrate. They have a rather low specific gravity so that they remain in suspension while the liquid is being filtered.

Removal of blue-black discoloration.—The blue-black color of vinegar is mainly due to a combination of tannin compounds and iron which is usually introduced through contamination with water and the equipment used.

Kreipe (1932) recommends the use of gelatin in the proportion of 2 to 4 grams per 100 liters of the vinegar. The gelatin is first dissolved by heating in a small amount of vinegar. It combines in part with the tannin and gradually flakes out. These flakes settle to the bottom. After some days the clarification is finished and when the sediment has settled, the clear supernatant liquid can be carefully drawn off.

Packing or bottling.—When the vinegar has been aged and clarified it can be bottled in suitable containers. Commercially, the product is put in bottles, sealed, and pasteurized. For home use, it can be kept in containers that have been steamed or sterilized. The finished product is kept in a cool room or cellar.

Pasteurization.—Pasteurization has for its object the preservation and maintenance of the strength of vinegar. Microorganisms that are responsible for the deterioration of the product are killed at temperatures ranging from 60 to 71° C.

Vinegar is usually pasteurized in loosely corked bottles or other suitable containers by submerging the same in tanks of water heated to proper temperatures for about 20 to 30 minutes.

MATERIALS USED

Of course none of the materials used were unripe, rotten, or decayed, since decayed and dirty materials impart an unpleasant and undesirable flavor or aroma to the resulting product. Only fully ripe and sound fruits, raised at the Lamao Horticultural Station of the Bureau of Plant Industry, were used in the experiments. The nipa sap was furnished by Mr. Francisco Marasigan, of Paombong, Bulacan.

1. Varieties of bananas used. Bananas (*Musa sapientum* L.).
   Varieties used for preparing single samples of vinegar: Ideep, Morado, Morong Datu, Tembotok.
   Varieties used for preparing the mixed samples of vinegar: Katali, Lacatan, Latundan, Tiparot, Saba, Toybok.
2. Sap of nipa (*Nypa fruticans* Wur.).
3. Water from coconut (*Cocos nucifera* L.).

4. Fruits:
   Perunkila (*Carissa carandas* L.).
   Lipoti (*Eugenia curanii* C. B. R.).

Other fruits containing a sufficient amount of fermentable sugars can also be used for preparing vinegar.

EXPERIMENTAL

VINEGAR FROM BANANAS

Process.—Seven varieties of bananas, such as the Ideep, Morado, Morong Datu, and Tembotok, were used for single determinations. For purposes of differentiation and comparison, mixed mashes were also made out of Katali, Lacatan, Tiparot, Saba, and Toybok.

Bananas contain an average of about 18 per cent fermentable sugars. The peel and pulp, when ground, gives a thick and viscous mash which prevents a thorough incorporation of the yeasts. About an equal amount of water is added to the mash to make it semifluid and then sufficient sugar is added to bring the sugar content up to about 15 per cent.

The Morado bananas, weighing 683.3 grams, were passed through a meat grinder and then mixed with about an equal amount of water and 125 grams of sugar. The resulting mixture had around 16 or 17 per cent sugar, or enough to produce vinegar of about 7 per cent acetic acid. About 250 cc. of yeast starter was added and the whole set aside in a 3-liter glass jar having a wide mouth. The jar was covered with cheesecloth to prevent the entrance of flies and other insects. Fermentation set in within a day and continued for about two weeks. Alcoholic fermentation was recognized by the continuous evolution of small bubbles of carbon dioxide gas. The pulp was buoyed up by the escaping gas during the fermentation and thus the solids were mechanically separated from the liquid portion. The mash was stirred now and then to promote a thorough alcoholic fermentation.

TABLE 2.—*The alcohol content of the fermented banana juice*

Serial No.	Material	Specific gravity; 25°/25°	Alcohol; per cent by weight	Sugar; per cent alcohol by weight x 2
CI	Morado	0.98730	7.38	14.76
CII	Tembotok	0.98178	11.07	22.14
CIII	Ideep	0.98571	8.38	16.76
CIV	Morong Datu	0.98612	8.14	16.28
CV	Mixed mash	0.98039	11.96	23.92

The completion of alcoholization was indicated by the decreasing production of gas bubbles. This took place in about two weeks. The liquid was then strained through cheesecloth. The alcohol content was determined by the pycnometer method. The results are shown in Table 2. About 300 cubic centimeters of good fresh strong nipa vinegar was added to start acetification. The container was left undisturbed. A film of "mother vinegar" or mycoderma aceti was rapidly formed on the surface, indicating rapid development of acetic bacteria. The acetic acid content was determined from time to time by titration with the use of a standard alkali solution. The results are shown in Table 3.

The same process was followed with the other varieties determined. For Tembotok, the sample used was 762.4 grams, for Ideep, 1,124.4 grams, and for Morong Datu, 610 grams. The results are shown in Table 3.

Mixed mashes consisting of the peel and pulp of Katali, Lacatan, Latundan, were also made. The same method as that followed for the Morado was used. The results are given in Table 3.

TABLE 3.—*Rate of acetification of banana cider*

Age		Acetic acid				
Date	Days	Morado	Tembotok	Ideep	Morong Datu	Mixed mash
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
October 21, 1932		2.18	1.92	2.29	1.15	2.50
October 26, 1932	5	2.26	2.29	2.40	2.20	2.82
November 2, 1932	13	2.38	2.45	2.58	2.80	3.31
November 7, 1932	18	2.43	3.35	2.79	3.38	3.78
November 12, 1932	23	3.48	3.79	3.49	3.79	4.52
November 17, 1932	28	3.84	4.51	3.76	4.08	5.28
November 22, 1932	33	4.22	5.24	4.37	4.51	5.89
November 28, 1932	39	4.36	5.53	4.73	4.87	6.42
December 3, 1932	43	4.36	5.52	4.73	4.84	6.42

VINEGAR FROM NIPA SAP

(*Nypa fruticans* Wur.)

Process.—The experiment on the production of vinegar from the sap of nipa was carried on in two parts (Parts I and II). Part II was started a month earlier than Part I.

Part I was divided into four samples using equal amounts of the sap.

Sample A, containing about 3 liters, was neutralized with calcium carbonate, then heated to boiling, cooled and fermented with the use of the commercial yeast. The treatment with

calcium carbonate had for its object the neutralization of the small amount of acetic acid present in the sample, that would interfere with proper fermentation of the sample. Heating kills the organisms that may cause deterioration of the product. The commercial yeast was first dissolved with a little nipa juice before applying it to the whole sample. The alcoholic fermentation was completed in about a week. Acetification was started by adding 800 cubic centimeters of the nipa vinegar. The acidity was determined once a week. The results are shown in Table 4.

TABLE 4.—*Part I. The rate of acetification of nipa vinegar*

Age		Acetic acid			
Date	Days	Sample A	Sample B	Sample C; control	Sample D
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*
November 2, 1932		2.91	3.34	3.68	1.41
November 7, 1932	5	3.13	3.43	3.72	1.18
November 12, 1932	10	3.42	4.74	4.20	2.50
November 17, 1932	15	3.45	4.87	4.52	2.85
November 22, 1932	20	4.01	5.36	4.97	3.73
November 28, 1932	26	4.00	5.38	4.97	3.70
December 3, 1932	31	4.00	5.35	4.97	3.70
December 8, 1932	36	4.00	5.35	4.92	3.60

Sample B, using the same amount as Sample A, was heated to boiling, cooled, and fermented with the use of yeast. The acetification was subsequently followed. The acidity was also determined.

Sample C served as control.

Sample D was heated to boiling with 12 cubic centimeters of 6 per cent sulphurous acid, heated to boiling, cooled, and fermented with the use of commercial yeast. The sulphurous acid treatment prevents the growth of vinegar eels, molds, and other microörganisms. The results are shown in Table 4.

Part II. Another batch of nipa sap was divided into three samples.

Sample A, in which two 1-liter bottles were filled with vinegar, pasteurized at 65° C. for thirty minutes, stoppered with a cork and sealed with paraffin. The acidity was determined on the first and last days of observations.

Sample B, in which two 1-liter bottles were filled with the sap and plugged with cotton. This was not pasteurized.

Sample C, divided into Sample C_1, contained about one-third of the liquid contents, C_2 contained three-fourths, Sample C_3 was filled with the liquid to the neck.

The same processes of alcoholic and the subsequent acetous fermentations were observed. The bottles were kept in a cellar with a temperature ranging from 24 to 26° C. The results are shown in Table 5.

TABLE 5.—*Part II. The rate of acetification of nipa vinegar*

Age		Acetic acid				
Date	Days	Sample A	Sample B	Sample		
				C_1	C_2	C_3
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
September 24, 1932	.....	2.46	3.32	2.97	3.45	3.02
October 1, 1932	7	.....	3.60	3.02	3.03	2.99
October 8, 1932	14	.....	3.64	3.28	3.08	3.08
October 15, 1932	21	.....	3.76	3.30	3.14	3.07
October 22, 1932	28	.....	4.35	3.59	3.17	3.07
October 29, 1932	35	.....	4.36	4.65	3.08	3.08
November 5, 1932	42	.....	4.34	4.66	3.12	3.11
November 12, 1932	50	.....	4.34	4.64	3.08	3.11
November 21, 1932	89	3.06	4.27	4.11	3.57	3.09

VINEGAR FROM COCONUT WATER

Process.—The water obtained fresh from mature nuts was placed in a wide-mouthed glass jar of two liters capacity. Commercial yeast, previously dissolved in some coconut water, was added to the sample. Within 12 hours the liquid was fermenting very rapidly. The evolution of gas bubbles was vigorous in about two days. Stirring of the contents helped in the formation of alcohol. When alcoholization had ceased, the sample was inoculated with nipa vinegar to start the acetification. The rate of acetification was determined by titration with standard alkali at frequent intervals. The results are shown in Table 6.

TABLE 6.—*Maximum acidity developed by coconut water and fruits*

Material	Acetic acid Per cent
Coconut water	3.00
Perunkila	4.00
Lipoti	5.23
Bananas:	
Morado	4.36
Tembotok	5.53
Indeep	4.73
Morong Datu	4.87
Mixed banana mash	6.42

VINEGAR FROM FRUITS

Process.—Only two kinds of fruits were used, namely, the Perunkila and Lipoti. They were considered as waste after having become over-ripe. By following similar processes to

that used in the preceding experiments, vinegar was also obtained from these fruits. The results are shown in Table 6. Many other Philippine fruits could be used for vinegar making in the homes and on the farms.

V. RESULTS AND DISCUSSION

The results are shown in Tables 2 to 6. As shown in Table 2, the alcohol content of fermented banana juice varies from 7.38 per cent for the Morado variety to 11.96 per cent of the mixed mash. Of the singly determined varieties, the Tembotok gives the highest with 11.07 per cent.

The approximate sugar content of the original juices is found by multiplying the per cent by the weight of alcohol by 2.

Table 3, gives the average per cent of acidity of the banana cider. It may be noted that the mixed mashes give a higher percentage of acidity than any of the separately determined varieties. The maximum was reached on the 38th day with 6.42 per cent. Adding to this about two weeks for alcoholization, the total period from the beginning to the maximum production of acidity, would be 52 days. Of the separately determined varieties the Tembotok gave the highest, with 5.33 per cent.

In general, however, the banana vinegar produced gave percentages of acidity which are well over the legal standard of 4 per cent.

The banana vinegar obtained retained the aroma of the original substance. It is clear and pale brown.

The rate of acetification of the nipa vinegar is shown in Tables 4 and 5. The maximum acidity was reached on the twentieth day for sample A, C, and D and on the 26th day for sample B. Excepting sample D, in which sulphurous acid was used, which may have retarded the acetification somewhat, all the rest developed fairly high percentages of acidity. The control came next to sample B for acetic acid content. Evidently, the heating process may have eliminated the destructive or undesirable microörganisms in the liquid so that the acetification developed favorably.

Table 5 shows the rate of acetification of nipa vinegar in bottles kept in a cellar with a temperature ranging from 24° to 26° C.

Sample A, which was kept in sealed bottles, did not develop a high percentage of acidity, the average range being from 2.46 to 3.06 per cent. This had its parallel results with bottles C_3

of sample C which were filled to capacity, and which gave 3.11 per cent acetic acid.

Moreover, sample B, which was in a bottle plugged with cotton developed a high acetic acid content of 4.27 per cent. Sample C_1, which contained the least amount of vinegar, developed a higher per cent acidity of 4.11 per cent than that of the sample C_3 where the bottles were filled to capacity.

Table 6 shows the acidity developed by the coconut water and fruits. The water of coconut gave only 3 per cent. This may be accounted for by the fact that coconut water contains low per cent sugar. The Perunkila and Lipoti gave per cent acidities of 4 and 5.23, respectively. The single varieties of bananas gave an average of 4.87 per cent while that of the mixed mashes gave 6.42 per cent.

SUMMARY

1. The banana varieties studied for preparing single samples of vinegar, were the Ideep, Morado, Morong Datu, and Tembotok; for the mixed samples, Katali, Lacatan, Latundan, Tiparot, Saba and Toybok.

2. The fruits studied were the Perunkila and Lipoti, and the palm toddies were nipa and coconut water.

3. The alcoholic and its subsequent acetic fermentation was carried on at the ordinary room temperature, ranging from 26.5° to 35° C., except for Part II of the nipa vinegar where a temperature of from 24° to 26° C. was maintained.

4. The banana cider of the mixed mash gave a higher per cent alcohol by weight than any of the individual varieties determined. Likewise, in the acetic fermentation, the mixed banana mash gave a higher per cent of acetic acid.

5. In general, the banana vinegar produced in this experiment gave percentages of acidity higher than the legal standard of 4 per cent. It retained the aroma of the original substance, and was a clear, pale brown.

6. When the nipa sap is first heated to boiling then cooled and subsequently fermented and acetified, a higher per cent of acetic acid is produced in the resulting vinegar.

7. Fruits such as the Perunkila and Lipoti produced vinegars of 4 and 5.23 per cent acetic acid, respectively.

8. The coconut water, because of its low content of sugar, gave a vinegar of low acetic-acid content.

9. Methods of preparing vinegar from fruits and saccharine juices were described.

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CHARACTERISTICS OF PHILIPPINE VINEGARS [1]

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Vinegar is a commodity indispensable in every household. It finds extensive use in the pickling of vegetables and fruits. The characterictics of foreign vinegars, the American, for example, have been extensively studied in order to establish standards of purity and safe-guard the public from fraud.

Philippine vinegars, however, have been little studied. A few analyses have been made in the course of investigations pertaining to alcohol manufacture. Thus, Gibbs (1911) reported the analyses of three samples of nipa vinegar; the total solids, ash, phosphorus pentoxide, acetic acid, alcohol were determined; and analyses of five samples of coconut vinegar were also given.

The present study was made to find out the characteristics of native vinegars and to compare them with those of foreign manufacture.

MATERIALS AND METHODS

The common Philippine vinegars may be classified according to their origin as follows:

1. Palm vinegars.
   (*a*) Cabo negro or kaong.
   (*b*) Coconut.
   (*c*) Nipa.
   (*d*) Buri.
2. Cane-juice vinegars.
   (*a*) Straight.
   (*b*) Basi.
3. Artificial vinegar prepared from glacial acetic acid.

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Fruit juices are also sources of vinegars, but are rather rare. An insight into the method of manufacture aids in the interpretation of the analyses. The native method of preparation is invariably reduced to one method, which is spontaneous fermentation. In the case of palm and cane-juice (straight) vinegars, the procedure is to place the collected sap or juice in containers (usually large earthenware jars called *tapayan*), cover them with wooden slabs, and set the containers aside while the liquid ferments spontaneously. The vinegar is considered ready for consumption when it is sour enough to the taste. The product thus obtained is usually turbid or opalescent, slightly aromatic, and with a pronounced acetic-acid odor.

Basi vinegar may be considered as an accidental product in the preparation of the alcoholic beverage known as basi. This drink is made by boiling sugar-cane juice until it is almost two-thirds its original volume and fermenting the resulting syrup. Fermentation takes place spontaneously. As is well known, the sugar is first acted upon by yeast, forming alcohol. This is the process desired in the manufacture of alcoholic beverages. Some microörganisms, however, may act on the alcohol as soon as formed and convert it into acetic acid. This second stage of fermentation is not desired in the making of a beverage inasmuch as the acid taste is displeasing; also, when sufficient acetic acid accumulates, the formation of alcohol diminishes to such an extent as practically to stop it altogether. Although useless as a drink, the acetified liquor thus produced may be used as a vinegar. This is the origin of basi vinegar.

Artificial vinegar is pure acetic acid diluted with water so as to contain 4 per cent of the acid, and colored with burnt sugar (caramel) to an amber liquid.

Samples of these different kinds of vinegars were obtained from several localities for analysis. Following the methods of the Assocation of Official Agricultural Chemists, the following constituents were determined: specific gravity, acidity, total and soluble solids, total and soluble ash, alkalinity of soluble ash, phosphorus pentoxide in the soluble ash, and reducing sugars. The acidity and aroma are of prime importance, but while the acidity may be measured, there is no quantitative method of estimating the flavor. The other constituents determined show the character of the sample and are of value in fixing standards of purity, and in ascertaining adulteration.

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TABLE 1.—*The chemical composition of some Philippine vinegars*

	Specific gravity	Acetic acid	Solids			Total ash	Soluble ash
			Total	Dissolved	Suspended		
	28°/28°C.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
I. Cabo negro toddy:							
1. Batangas Province, Tanauan	1.0084	2.76	1.73	1.14	0.57	0.51	0.43
II. Coconut toddy:							
1. Laguna Province, Bay	1.0136	1.87	5.02	4.63	0.39	0.46	0.40
2. Tayabas Province, Lucena	1.0041	2.28	2.27	2.16	0.11	0.52	0.45
Average	1.0089	2.08	3.65	3.40	0.25	0.49	0.43
III. Nipa vinegar:							
1. Bataan Province, Balanga	1.0098	2.96	2.27	2.14	0.13	0.97	0.90
2. Batangas Province, Tanauan	1.0113	2.38	1.90	1.74	0.16	0.82	0.67
3. Bulacan Province, Malolos	1.0120	3.00	2.43	2.23	0.20	0.72	0.64
4. Cavite Province, Tanza	1.0107	2.95	3.01	2.38	0.63	0.85	0.81
5. Laguna Province, Los Baños, coconut grove A	1.0038	0.87	0.55	0.28	0.27	0.24	0.22
6. Laguna Province, Los Baños, coconut grove B	1.0091	2.01	0.91	0.55	0.36	0.43	0.38
7. Laguna Province, Los Baños, Tong Store	1.0045	1.67	0.96	0.86	0.10	0.36	0.34
8. Manila, Sibacong	1.0108	3.66	1.93	1.63	0.30	0.76	0.73
9. Tarlac Province, Victoria	1.0056	1.33	0.79	0.79	.....	0.39	0.31
Average	1.0086	2.31	1.64	1.40	0.20	0.62	0.56
IV. Sugar cane:							
A. Straight—							
1. Batangas Province, Batangas	1.0164	1.10	5.96	5.60	0.36	0.34	0.21
2. Batangas Province, Batangas	1.0067	6.86	5.27	5.27	.....	0.35	0.20
3. Ilocos Sur Province, Magsingal	1.0047	6.34	7.48	7.36	0.12	1.71	0.66
4. Mountain Province, Baguio	1.0200	3.97	3.96	3.88	0.08	0.34	0.12
5. Do	1.0200	4.07	3.77	3.25	0.52	0.35	0.15
6. Do	1.0100	2.79	1.15	1.09	0.06	0.36	0.24
7. Tarlac Province, Victoria	1.0275	2.89	5.79	5.57	0.22	0.75	0.56
8. Zambales Province, San Narciso	1.0265	1.29	2.90	2.63	0.27	0.67	0.25
Average	1.0165	3.66	4.54	4.33	0.21	0.61	0.30
B. Basi—							
1. Tarlac Province, Victoria	1.0191	1.63	17.74	13.86	3.88	0.61	0.43
2. Zambales Province, San Narciso	1.0912	3.70	21.36	20.97	0.39	1.19	0.21
Average	1.0552	2.67	19.55	17.42	2.13	0.90	0.32
V. Artificial	1.0062	4.55	0.46	0.46	.....	0.03	0.03
VI. Cider, Commercial	1.0112	5.05	1.32	1.32	.....	0.23	0.17

TABLE 1.—*The chemical composition of some Philippine vinegars*—Continued

	Alkalinity of soluble ash	P_2O_5 in soluble ash	Reducing sugars	Reducing sugars in total solids	Ash in total solids	Soluble ash in total ash
	cc o.in per 100 cc.	*mg per 100 cc.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
I. Cabo negro toddy:						
1. Batangas Province, Tanauan	27.75	26	0.05	2.89	29.47	84.31
II. Coconut toddy:						
1. Laguna Province, Bay	14.35	30	1.20	23.90	9.16	86.96
2. Tayabas Province, Lucena	16.48	15	trace.		22.91	86.54
Average	15.42	23	0.60		16.04	86.75
III. Nipa vinegar:						
1. Bataan Province, Balanga	21.04	26	0.02	0.66	42.73	92.78
2. Batangas Province, Tanauan	20.67	12	trace.		43.16	81.71
3. Bulacan Province, Malolos	17.07	15	trace.		29.63	88.89
4. Cavite Province, Tanza	28.91	23	0.02	0.66	28.24	95.29
5. Laguna Province, Los Baños, coconut grove A	8.36	2	trace.		43.64	91.67
6. Laguna Province, Los Baños, coconut grove B	15.81	8	trace.		47.25	88.37
7. Laguna Province, Los Baños, Tong Store	11.80	12	0.09		37.50	94.44
8. Manila, Sibacong	26.63	17	0.07		39.38	96.05
9. Tarlac Province, Victoria	11.40	10	trace.		49.37	79.49
Average	17.97	14	0.02		37.80	90.32
IV. Sugar cane:						
A. Straight—						
1. Batangas Province, Batangas	10.59	26	0.30	5.03	5.70	61.76
2. Batangas Province, Batangas	11.16	20	0.65	12.33	6.64	57.14
3. Ilocos Sur Province, Magsingal	73.52	trace.	3.57	47.73	22.86	38.60
4. Mountain Province, Baguio	7.98	5	1.24	31.31	8.58	35.29
5. Do	10.59	10	1.06	28.12	9.28	42.85
6. Do	23.02	19	0.52	4.52	31.30	66.66
7. Tarlac Province, Victoria	50.68	64	0.57	9.84	12.95	74.67
8. Zambales Province, San Narciso	23.33	3	0.82	28.28	23.10	37.31
Average	27.12	22	1.09	24.00	13.43	49.18
B. Basi—						
1. Tarlac Province, Victoria	37.71	27	10.44	58.85	3.44	70.49
2. Zambales Province, San Narciso	24.90	trace.	14.26	66.76	5.57	17.65
Average	31.35	14	12.35	62.81	4.60	35.56
V. Artificial	1.42	trace.	0.09	0.19	0.65	100.00
VI. Cider, Heinz	18.80	8	0.27	20.45	17.42	73.91

RESULTS

The results of the analysis of twenty-five samples are given in Table 1. The first ten columns represent constituents actually determined; the last three columns are values computed from the preceding data and are given to show a certain relationship among the constituents.

DISCUSSION OF RESULTS

The results of the analysis of twenty-four locally prepared natural vinegars showed a general deficiency in acidity. The average value was 2.90 per cent, which was distinctly low when compared with the general requirement of the Federal Pure Food Law of 4 per cent. A few samples had very high acidity, notably the sugar-cane vinegars samples 2 and 3, which contained 6.86 per cent and 6.34 per cent acetic acid, respectively. Only four of the twenty-four samples could have passed the Federal standard for acidity. One sample was as low as 0.87 per cent. The palm vinegars are in general deficient in acidity, though since palm sap contains a high percentage of sugar it would be expected to yield vinegar of much higher acidity.

The total-solids content shows a wide range of percentages. Again, the cane-juice samples show higher percentages than do the palm vinegars. Those prepared from basi are markedly high in total solids; there are only two samples of basi analyzed, but they were both heavily charged with dissolved substances.

All these samples were analyzed without being filtered, and since nearly all of them were turbid or had a layer of sediment at the bottom of the container, it was thought best to attempt a quantitative measurement of the suspended matter by filtration and to determine the quantity filtered out. This was found to range from 3.88 per cent to mere traces.

The results of the determinations of total ash did not show any general trend except that sample 3 of straight cane-juice vinegar and sample 2 of basi vinegar had an unusually high total ash. These two samples did not contain phosphorus pentoxide (P_2O_5) as shown in column 9. The ash of both samples contained calcium. It is suspected that both came from limed cane juice. The lime precipitated all phosphorus as calcium phosphate. To the excess lime remaining in solution may be attributed the high percentage of total ash.

Column 9 shows the number of milligrams of phosphorus pentoxide in the soluble ash. As previously said, there were

two samples devoid of this constituent. Artificially prepared vinegar, too, has no phosphorus at all. Sample 5 among the nipa vinegars had a very low phosphorus pentoxide content. At the same time the percentages of acetic acid and total solids were also below the general trend. This may be taken as indicative of watering of the vinegar. If the constituents of this sample were multiplied by 3, the results would be in agreement with those of other samples. A large amount of water may, therefore, have been added.

It is significant that the vinegars coming from palms (column 10) have very little sugar remaining in them, while those prepared from cane juice, basi samples especially, have plenty. Such vinegars are sweet. A high percentage of sugar is an indication of improper fermentation. As stated before, there are two stages in the preparation of vinegar: the formation of alcohol from sugar and the subsequent acetification of the alcohol. The first stage should go to completion before the acetification is allowed to proceed, as otherwise, the formation of alcohol from sugar is inhibited. When this happens, the resulting vinegar is sweet and of low acidity. This is what took place in the course of fermentation of the basi vinegars.

In order to establish the interrelationships among the constituents the following were completed: the percentage of sugar in total solids, the percentage of ash in total solids, and the percentage of soluble ash in total ash.

The percentage of sugar in total solids gives a measure of the completeness of the alcoholic fermentation. It is to be seen in column 11 that the palm vinegars are generally completely fermented, for the sugar present in the total solids is very small. The opposite is true of the cane-juice vinegars; the basi vinegars contain on the average 62.81 per cent of their solids as sugars.

The per cent of ash in total solids (column 12) is expected to be constant for a given source of vinegar. This is easily seen to be the case, even if water has been added. A marked constancy is shown by the nipa vinegars. Even sample 5, which is rather below the trend in acetic acid, ash, alkalinity of ash, and phosphorus pentoxide, still shows this constancy. The average value for the nipa vinegars is 37.80 per cent. The coconut vinegars are not so constant and the average value is lower, being 19.15 per cent, or about half that of nipa. The cane-juice vinegars do not show any general trend, but as a rule give lower values than those for nipa.

The percentage of soluble ash in total ash should be still more constant in quantity than the per cent ash in total solids. That this is so, may be recognized from the following consideration: Sugar and starch leave no ash when incinerated. If added to vinegar or to the source of the vinegar, they would increase the total solids without altering the total ash. Therefore, the percentage of ash in total solids (column 12) would change in value; but the percentage of soluble ash in the total ash would still remain unchanged. It is then expected that this last percentage may be used to identify a particular vinegar, despite the addition of sugar, alcohol, acetic acid, or starch to increase the acidity. That this supposition is at least partially justified is shown by column 13. There is only one sample of nipa vinegar (No. 9) that has the percentage of soluble ash in total ash below 80 per cent. All the others have high values with an average of 90.32 per cent. Not one of the cane-juice or basi vinegars approaches such a high percentage. The other palm vinegars, coconut and cabo negro, are also characterized by a high percentage of soluble ash in total ash. In general, the greater part of the ash of palm vinegars is soluble in water.

Table 2 presents the averages of the different kinds of vinegars analyzed compared with the Federal standards. It shows that on the average Philippine vinegars are low in acidity, but meet the standard fairly well.

TABLE 2.—*Analysis of coconut sap vinegar* [a]

Sample	Specific gravity	Acetic acid	Total solids	Ash	Reducing sugar	Alcohol
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Laguna Province, Nagcarlang	1.0100	1.51	2.06	0.45	.....	7.37
Leyte Province, Maripipi	1.0132	3.41	3.57	0.55	0.67	4.50
Do	1.0432	3.31	3.56	0.56	0.68	4.50
Do	1.0400	3.00	1.62	0.53	0.63	5.25
Do	1.0400	3.00	1.45	0.57	0.83	5.25
Average	1.0235	2.85	2.45	0.53	0.70	4.57

[a] From Gibbs, Philip. Journ. Sci. 6: 147–206.

Table 3 gives the variation in composition of native and cider vinegars. The range in percentage of sugar in total solids in nipa samples is low, being from 0 to 9.37 per cent; for coconut it is from 0 to 23.9 per cent. Cider, basi, and sugar-cane vinegars always contain some sugar. Basi also has a very low value for ash in total solids, being lower than any other natural vinegar analyzed. This is due to the high percentage of sugars, which

increases the solids content without altering the quantity of ash. Nipa is notably high in the percentage of ash in total solids; the minimum, which is 28.24 per cent, is almost the maximum for coconut and sugar cane, while that for basi is very far below.

TABLE 3.—*Analysis of nipa vinegar.*[a]

Sample No.	Acetic acid	Total solids	Total ash	Phosphorus pentoxide	Alcohol
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
68758	2.17	1.35	0.66	.....	.....
68759	3.23	2.03	0.72	0.03	1.20
68760	3.03	1.54	0.72	.....	3.03
Average	2.81	1.64	0.70	0.03	2.12

[a] From Gibbs, Philip. Journ. Sci. 6: (1911) 99–145.

The variation in the percentages of soluble ash in total ash for nipa vinegars is from 79.49 to 96.05 per cent. Table 3 shows that these figures have never been attained by sugar-cane or basi vinegars. It should be pointed out also that all the samples of palm vinegars have values for the percentage of soluble ash in total ash that are higher than any other native vinegar, with the exception of a lone sample of sugar-cane vinegar, No. 7.

In general then, it is found that native vinegars have peculiarities of their own and require a different set of standards of purity than those already established. The history of the samples analyzed not being known with certainty, and the number of samples being insufficient, no well defined table of standards can be drawn. Table 3, which gives the variation in composition of native vinegars, may however, be used as a tentative one. It should be noted that the acidity of native vinegars is very much below standard compared with foreign standards. The American 4-per-cent acetic acid requirement being too high a lower percentage should be used as the standard for the local products. The raw materials of native vinegars, however, are so rich in sugars, as shown in Table 4, that a much higher percentage of acetic acid could be obtained with proper fermentation methods.

SUMMARY AND CONCLUSIONS

1. Twenty-five samples of native vinegars were analyzed to study their characteristics. Of these, one sample was from

kaong; four from coconut; nine from nipa; eight from sugarcane; two from basi; and one artificially prepared.

2. It was found that local vinegars have characteristics of their own. They have low acetic acid content with an average of 2.9 per cent; the palm vinegars generally have a very low sugar content while cane-juice vinegars are very high in sugars.

3. The palm vinegars, the nipa samples especially, have a very high percentage of soluble ash in the total ash; this peculiarity may help identify nipa vinegars despite the addition of sugar, starch, acetic acid, or alcohol.

4. The palm toddies or sap are high in sugars and with proper fermentation methods a much higher percentage of acetic acid than those found by the analysis could be obtained.

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PHILIPPINE JOURNAL OF AGRICULTURE

VOL. IV, No. 1, 1933

ERRATA

Page 73, the title should read: "The Effect . . . Yield" instead of "The Effect . . . Field:"

Tables 2, 3 and 4 on page 77, change all "+" signs to "±" signs.

Page 76, line 12, "different" should read "difference."

Page 77, table 3, first column, last figure should read "35.7± 1.33" instead of "45.7+1.33."

Page 78, paragraph 4 should read: "Figure 2 presents in a graphic way . . . ."

Page 80, last line, "3.6+2.29" should read "9.6±2.39."

Pages 80 and 81 under "Effect of Mulch on Yield," change all "+" signs to "±" signs.

Page 80, under "Effect of Mulch on Yield," line 6, change "+" signs between 1.17 and 21.2 to a ","

Page 82, paragraph 3, "fruits rots" should read "fruit rots."